ABSTRACT BOOK

1ST INTERNATIONAL EMERGING SCHOLARS FORUM (IESF-2025)

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Abstract Book: 1st International Emerging Scholars Forum (IESF-2025)

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Preface

We are pleased to host the *1st International Emerging Scholars Forum (IESF-2025)* on **"Building Resilient Agri-Food Systems in a Climate-Vulnerable World."** This milestone event highlights the vital contributions of early-career researchers to advancing sustainability, equity, and innovation in agri-food systems worldwide.

The response to IESF-2025 has been remarkable, with an impressive number of high-quality submissions from across the globe. Following a rigorous review by our technical committee and expert reviewers, **171 abstracts** were selected for presentation. These reflect diverse disciplines, methodologies, and regional perspectives, showcasing the breadth and dynamism of emerging scholarship in this field.

The forum provides a vibrant platform for interdisciplinary dialogue. Key themes include climate-smart agriculture, water–energy–food nexus optimization, sustainable resource management, green innovation, and ecosystem service valuation. Other sessions explore market resilience, value chain transformation, digital agriculture, and the behavioral dimensions of food and nutrition security.

Technological innovation features prominently, with discussions on AI, remote sensing, blockchain, and big data for productivity, traceability, and inclusive growth, while also addressing the ethics and equity of digital tools. Institutional and policy reforms are another core focus, addressing land tenure, gender equity, migration, and community-led adaptation, with special attention to indigenous knowledge and participatory governance.

Emerging methodologies such as life cycle assessment, circular bioeconomy modeling, experimental approaches, and mixed-methods research are well represented, bridging economics, ecology, and the social sciences to address complex sustainability challenges.

We extend our heartfelt thanks to all authors, reviewers, session chairs, and organizing partners for their dedication to making IESF-2025 possible. We hope this forum inspires meaningful collaborations, informs policy, and contributes to building resilient, inclusive, and sustainable agri-food systems for the future.

IESF-2025 Organizing Committee

Organizing Committee

The planning and preparation of the **1st International Emerging Scholars Forum (IESF-2025)** took place under the guidance of a distinguished team of academic leaders and professionals committed to shaping a globally relevant and intellectually engaging event. We are privileged to have **Prof. Dr. Asghar Ali** from the Institute of Agricultural and Resource Economics, University of Agriculture, Faisalabad, as the **Conference Chair**, providing strategic direction and academic leadership. The Honorary Planning Committee comprises eminent scholars from Türkiye, China, Mongolia, Uzbekistan, Indonesia, and Pakistan, who are actively contributing their insights and experience to help design a forum that addresses pressing challenges in agriculture, sustainability, and development.

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Prof. Dr. Asghar Ali, Institute of Agricultural and Resource Economics, University of Agriculture, Faisalabad, **Pakistan**

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Dr. Muhammad Umar Farrukh, Department of Economics, GC Women University, Sialkot, **Pakistan**

The Organizing Committee, Technical Program Committee, and Conference Secretaries worked diligently to ensure the successful execution of IESF-2025. Their efforts in program development, participant coordination, abstract review, and outreach reflect a shared commitment to building a collaborative and inclusive platform for emerging scholars. As preparations continue, we express our deep appreciation to all members involved for their initiative, dedication, and leadership in bringing this important event to life. We look forward to welcoming participants from around the world to this dynamic and forward-thinking virtual forum in August 2025.

Collaborators

Our network of collaborators includes a diverse set of **national and international organizations**, each bringing expertise and thought leadership to the forum. These include:

- University of Agriculture, Faisalabad (Pakistan)
- The Agricultural Economist and The AgEcon Frontiers (TAEF) (Pakistan)
- Selçuk University, Konya (Türkiye)
- Zhejiang University, Zhejiang (China)
- Mongolian University of Life Sciences, Ulaanbaatar (Mongolia)
- MNS University of Agriculture, Multan (Pakistan)
- Akdeniz University, Antalya (Türkiye)
- Andijan Institute of Agriculture and Agri-Technologies, Andijan (Uzbekistan)
- Universitas Gadjah Mada, Yogyakarta (Indonesia)
- University of Sargodha (Pakistan)
- The University of Faisalabad (Pakistan)
- Government College Women University, Sialkot (Pakistan)
- Federal University Dutse (Nigeria)
- Agricities (Türkiye)

- Asian Institute of Eco-civilization, Research, and Development, Islamabad (Pakistan)
- Pakistan Economic Frontier, Islamabad (Pakistan)

Together, these institutions support IESF-2025 as a premier platform for **emerging scholars, postgraduate researchers, and early-career professionals** working at the intersection of **agriculture, environment, climate change, policy innovation, food systems, and sustainability**.

The forum will feature **keynote addresses**, **theme-based panel discussions**, and **concurrent sessions for presentations**, offering rich opportunities to share research, build networks, and foster collaborative solutions to global challenges.

Conference Topics

The forum was held virtually from August 20–22, 2025, hosted from University of Agriculture, Faisalabad, Pakistan, under the theme: "Emerging Insights for a Resilient Future: Climate, Equity, and Innovation in Agri-Food Systems." The topics of the conference included:

Climate Resilience & Sustainable Resource Economics and Management

Exploring economic tools and strategies to enhance resilience in the face of climate and environmental challenges.

- Adoption and impact assessment of climate-smart agriculture.
- Optimization of the water-energy-food nexus, including emerging issues such as microplastics in agro-ecosystems.
- Carbon pricing, green innovation, and the valuation of ecosystem services.

Agri-Food System Transformation, Food Security & Market Dynamics

Investigating shifts in market structures, trade, and value chains under conditions of uncertainty and transformation.

- Digital agriculture platforms, value chain resilience, and implications for competition policy.
- Trade liberalization, evolving food security strategies, and post-pandemic supply chain adaptations.
- Behavioral economics of food choices, nutrition, and consumer decision-making.

Technology & Data-Driven Agriculture

Harnessing advanced technologies to enhance productivity, traceability, and inclusive innovation in agriculture.

- Artificial intelligence and remote sensing for precision agriculture and yield prediction.
- Blockchain technologies for traceability, transparency, and ethical sourcing.

- Ethical considerations in big data use and expanding access to digital technologies for smallholder farmers.

Equity, Policy & Institutional Innovation

Focusing on policy frameworks and institutional mechanisms that promote inclusive and equitable agri-food systems.

- Land tenure reform, gender equity, and labor migration in rural economies.
- Innovative subsidy design, payments for ecosystem services (PES), and multilateral governance approaches.
- Integration of indigenous knowledge systems and community-led adaptation strategies.

Emerging Methodologies & Interdisciplinary Approaches

Advancing methodological frontiers and cross-disciplinary collaborations to tackle complex agri-food challenges.

- Life cycle assessment (LCA), circular bioeconomy modeling, and sustainability metrics.
- Field and lab experiments in behavioral and development agri-economics.
- Mixed-methods research bridging economics, ecology, and social sciences.

Keynote Speakers

Professor Kadambot H.M. Siddique AM, FTSE, FAIA, FNAAS, FISPP, FAAS, FPAS is an internationally recognized agricultural scientist and Hackett Professor of Agriculture Chair and Director of the UWA Institute of Agriculture, The University of Western Australia (UWA). With over 35 years of pioneering contributions to crop science, Professor Siddique has built an exceptional career advancing global food security, particularly in dryland agricultural systems. After completing his PhD at UWA in 1985, he served in key scientific and leadership roles, including Principal Scientist at the Department of Agriculture and Food Western Australia (DAFWA), Director of CLIMA, and founding Director of the UWA Institute of Agriculture.

Professor Siddique's research focuses on crop physiology, production agronomy, genetic resources, and breeding innovations in cereals and grain legumes. His studies on chickpea adaptation and water-use efficiency under terminal drought conditions have significantly strengthened the Australian grain legume industry, now valued at over $600 million annually. He has led major national and international research programs addressing wheat productivity, root phenotyping, phosphorus use, and climate resilience. His publications are highly cited and have shaped global understanding of crop adaptation in Mediterranean and semi-arid environments.

His impact extends beyond research. He has secured over $80 million in funding, trained more than 60 postdoctoral fellows and 60 PhD/MSc students, and built enduring collaborations across Asia, the Middle East, and Africa. Notable initiatives include the UWA–Lanzhou University dryland agriculture partnership, the ACIAR-funded “Seeds of Life” project in Timor-Leste, and the establishment of UWA’s Pingelly Future Farm 2050.

A frequently invited speaker and a key contributor to capacity-building, Professor Siddique is also deeply engaged in teaching and policy advisory. His awards and fellowships including FTSE and FAIA, reflect his global leadership in agricultural innovation, sustainability, and education. His work bridges science, practice, and policy for a more food-secure future.

Professor Dr. Md. Aminur Rahman is an internationally recognized marine biologist and fisheries expert with over 30 years of academic, research, and development experience across Asia, North America, and Oceania. He earned his PhD in Marine and Environmental Sciences from the University of the Ryukyus, Japan (2001), followed by prestigious postdoctoral fellowships with the Japan Society for the Promotion of Science (JSPS) and the Smithsonian Tropical Research Institute (USA), focusing on sea urchin reproduction, aquaculture, and hybridization across Indo-Pacific and Atlantic regions.

His career includes a two-decade tenure as Senior Scientist at the Bangladesh Fisheries Research Institute (1988–2007), where he contributed to the conservation and aquaculture of endangered native species in collaboration with FAO, DFID, and WorldFish. Internationally, he served as Senior Research Fellow at Universiti Putra Malaysia (2010–2017) and Professor/Advisory Professor at the FAO World Fisheries University, South Korea (2017–2021). He currently chairs the Department of Fisheries and Marine Bioscience and directs the Institute of Higher Education and Research at Jashore University of Science and Technology (JUST), Bangladesh.

Professor Rahman’s expertise includes marine and freshwater biology, aquaculture, reproductive ecology, stock assessment, and climate change impacts on fisheries. He has published over 193 peer-reviewed articles, two books, 17 chapters, and 48 conference proceedings. With a Google Scholar h-index of 31 and over 3,100 citations, he has supervised more than 53 students and led 36 research projects.

An active academic leader, he holds editorial positions in 35 international journals, has chaired 44 international sessions, and delivered 70 keynote or invited lectures. A certified SCUBA diver, he has conducted 70 marine expeditions and received 45 awards for his contributions to marine science and the blue economy.

Professor Rahman has received 45 national and international awards recognizing his outstanding contributions to marine science, aquaculture, and fisheries development. His active collaborations with leading institutions such as Smithsonian (USA), ANSTO (Australia), and King Abdulaziz University reflect his global leadership in the sustainable utilization and conservation of marine bioresources.

Dr. M. Ejaz Qureshi is a distinguished agricultural and resource economist with over 20 years of experience across academia, government, and international development organizations. He currently serves as an Honorary Associate Professor at the Fenner School of Environment and Society, Australian National University (ANU), where he supervises postgraduate research and lectures on natural resource management, agricultural policy, and environmental governance.

Dr. Qureshi also holds a senior leadership role as Assistant Director in the First Nations Policy Branch at Australia's Department of Agriculture, Fisheries and Forestry (DAFF). In this capacity, he has contributed to shaping Australia's First Nations Policy Platform, integrating Indigenous knowledge into environmental management, and leading national efforts to evaluate and strengthen the country's biosecurity system.

His interdisciplinary expertise spans water and land resource management, food and nutrition security, climate change, forest policy, and biosecurity. His career includes impactful roles at CSIRO, ABARES, James Cook University, University of Queensland, the Food and Agriculture Organization (FAO) of the United Nations, and the Australian Centre for International Agricultural Research (ACIAR). At FAO, he supported the implementation of Pakistan's agricultural policy. At ACIAR, he managed over 25 research-for-development projects across Asia and the Pacific, advancing evidence-based agricultural development.

Earlier at CSIRO and ABARES, Dr. Qureshi led projects on pesticide regulation, salinity, and natural resource economics, while also advising the government on environmental policy and

biosecurity preparedness. He has provided briefings to the Australian Parliament and contributed extensively to public policy development.

Dr. Qureshi's scholarly contributions include nearly 100 publications, including 40 peer-reviewed articles, six book chapters, and multiple technical reports. He has served as Guest Editor for *Food Security* and *Hydrogeology Journal* and as Associate Editor of the *Journal of Hydrology*. His work continues to influence sustainable agriculture and environmental governance in Australia and the Asia-Pacific.

ABSTRACTS

Keeping Classrooms Cool: A Circular Economy Approach to Heatwave-Resilient Schools in Pakistan

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1. Introduction:

Pakistan is experiencing increasingly intense and frequent heatwaves as a direct consequence of climate change, particularly in southern regions such as South Punjab. These extreme temperatures pose serious risks to student health, academic performance, and the overall safety of school environments. Conventional cooling systems like air conditioning are often unaffordable, energy-intensive, and impractical in resource-constrained settings. This underscores the urgent need for sustainable, cost-effective, and climate-resilient solutions tailored to local needs.

2. Objectives:

This study investigates how circular economy principles can be applied to enhance heatwave resilience in Pakistani schools. The focus is on developing scalable, low-cost, and environmentally sustainable cooling strategies that promote energy efficiency and community inclusion.

3. Methodology:

The research employs a multidisciplinary approach, combining design thinking, environmental engineering, and community-based participatory methods. Key strategies include the use of recycled and locally sourced construction materials, passive cooling architecture (e.g., cross-ventilation, reflective surfaces), rooftop gardens, green walls, shaded learning spaces, and other nature-based solutions. Data were gathered through field visits, stakeholder interviews, and pilot case studies in selected schools across South Punjab.

4. Results:

The findings demonstrate that integrating circular design elements significantly reduces indoor classroom temperatures, improves thermal comfort, and enhances student focus and attendance during heatwave periods. Successful prototypes—such as classrooms with reflective paint, ventilated rooftops, and low-cost insulation from reused textiles—show measurable improvements in energy savings and indoor climate regulation. Additionally, the approach fosters community engagement, local job creation, and a culture of sustainability within the education sector.

5. Conclusion & Recommendations:

A circular economy model provides a promising and replicable pathway to climate adaptation in schools, particularly in low-income and climate-vulnerable regions of South Asia. Policymakers, educational planners, and urban designers should prioritize circular design in school infrastructure projects, supported by capacity-building, cross-sector collaboration, and localized innovation. Further research is encouraged to evaluate long-term cost-benefit impacts and behavioral outcomes on students and school staff.

Keywords:

Circular Economy, Heatwave Resilience, Passive Cooling, Sustainable School Design, Climate Adaptation, Pakistan

Impact of Dietary Choices on the Health and Academic Performance of Secondary School Girls in Tehsil Jaranwala, District Faisalabad

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1. Introduction:

Healthy dietary choices are essential for maintaining overall well-being, especially during adolescence, a crucial stage of rapid physical growth and cognitive development. Dietary choices encompass individual decisions about food selection and intake, which directly influence nutritional status. Unhealthy eating patterns, such as excessive consumption of processed foods or nutrient deficiencies, are linked to obesity, metabolic disorders, and impaired immunity, while also negatively impacting cognitive function, concentration, and academic performance, thereby hindering long-term health outcomes.

2. Objectives:

This study aimed to assess the impact of dietary choices on the health and academic performance of secondary school girls in Tehsil Jaranwala, District Faisalabad.

3. Methodology:

The study was conducted in Tehsil Jaranwala, where five girls' secondary schools were selected out of a total of 53 using convenience sampling. From a total of 920 enrolled students in these selected schools, a sample of 129 respondents was chosen using simple random sampling. Data was collected through structured questionnaires focusing on dietary habits, health indicators, and academic outcomes.

4. Results:

The findings revealed that most students consumed three meals per day. Commonly consumed foods included vegetables, rice, and chapatti, while meat was less accessible. Fruit and eggs were frequently consumed when available. A notable portion of respondents expressed a preference for junk food depending on its availability. The data showed a strong correlation between healthier dietary choices and improved stamina, digestion, attention span, and overall academic performance.

5. Conclusion & Recommendations:

The study concluded that dietary choices are closely linked to the socioeconomic status of students. Those with better nutrition demonstrated superior physical health and academic achievement. The findings suggest the need for nutrition education programs in schools, along with policies to improve access to nutritious food, especially for economically disadvantaged students.

Keywords: Dietary Choices, Health, Academic Performance, Socioeconomic Status, Secondary School Girls

Impact of Overscheduling on the Health and Academic Performance of Private School Students

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1. Introduction:

Overscheduling refers to the practice of assigning numerous structured tasks or activities within a limited timeframe. Among children, this is often characterized by excessive participation in academic, extracurricular, and social commitments. In today's educational climate, particularly within private school systems, students are increasingly burdened with home tuition, religious studies, sports, and homework outside regular school hours. While these activities may foster personal development, they can also lead to physical exhaustion, emotional stress, and academic disengagement.

2. Objectives:

The present study investigates the effects of overscheduling on the health and academic performance of private elementary school students in Khurrianwala, Tehsil Jaranwala.

3. Methodology:

A total of eight leading private schools in the selected area were identified. From each school, 15 students were selected using a convenience sampling technique, resulting in a total sample size of 120 respondents. Data was collected through a structured questionnaire designed to capture students' daily routines, academic workload, and health-related concerns.

4. Results:

Findings revealed that a significant majority of students were engaged in multiple activities beyond school hours, including home tuition, Quran classes, and recreational sports. Commonly reported issues included decreased concentration during study hours, mental fatigue, physical stress, and mood disturbances. Students also reported pressure stemming from the need to meet academic expectations from both school and family.

5. Conclusion & Recommendations:

The study concludes that excessive scheduling negatively impacts both the mental and physical health of students, thereby affecting their academic performance. It recommends that schools and parents collaboratively support children in prioritizing and managing their workload. A balanced and flexible schedule is essential to foster both academic success and psychological well-being.

Keywords: Overscheduling, Academic Performance, Student Health, Time Management, Private School Education

Part-Time Work and Its Impact on Students' Career Development and Economic Growth

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1. Introduction:

Part-time employment, defined as working fewer than 35 to 40 hours per week, offers flexible income-generating opportunities, especially for students balancing educational and personal commitments. While part-time work can foster financial independence and soft skill development, it may also disrupt academic performance and long-term career planning. In Pakistan, an increasing number of university students are engaging in part-time jobs, particularly through online platforms, yet the broader impacts of this trend on career development and national economic growth remain underexplored.

2. Objectives:

This study aims to evaluate the impact of part-time work on the career development of university students and its implications for economic growth, with a specific focus on students at the University of Agriculture, Faisalabad.

3. Methodology:

The study targeted students enrolled in the Faculty of Social Sciences. A total of 130 students were selected through a purposive sampling method. Data were collected using a structured questionnaire and analyzed to examine the relationship between part-time employment, academic performance, skill development, and economic self-reliance.

4. Results:

Findings revealed that most students were engaged in part-time online work, primarily as tutors or freelancers on platforms like Fiverr and Amazon. Financial constraints were the key motivator for part-time employment. While such work enhanced students' communication skills, self-confidence, and economic autonomy, it also had adverse effects on academic performance particularly in terms of reduced class attendance and concentration. Students reported a lack of structured career guidance and limited access to skill-based training, which hindered their long-term career development.

5. Conclusion & Recommendations:

The study concludes that while part-time work contributes positively to students' financial independence and soft skill acquisition, it may compromise academic achievement and future career prospects without adequate support systems. Universities should integrate career counseling and skill development programs to help students align part-time work with their academic and career goals. Policymakers must also consider structured internship opportunities to balance economic needs with academic and professional growth.

Keywords: Part-time Employment, Student Career Development, Online Work, Academic Performance, Economic Independence, Skill Development.

Determinants of Flood Risk Mitigation Strategies among Rice Farmers in Kano State, Nigeria

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1. Introduction:

This study investigates the determinants of flood risk mitigation strategies among rice farmers in Dawakin-Kudu, Kano State, Nigeria. As climate variability increases the frequency of floods, understanding farmers' adaptation strategies is essential for ensuring sustainable agriculture and rural resilience.

2. Objectives:

To analyze socio-economic and institutional factors influencing the adoption of flood mitigation strategies by rice farmers in the study area.

3. Methodology:

Using a multistage sampling technique, data were collected from 110 rice farmers via structured questionnaires. Analytical methods included descriptive statistics and multivariate probit regression to identify key determinants of adopted mitigation practices.

4. Results:

The average age, household size, and farm size of respondents were 45 years, 7 persons, and 1.9 hectares, respectively. While 60% had attained at least primary education, access to credit and extension services remained limited. Key flood mitigation strategies included the adoption of early-maturing varieties (55.4%), adjustment of planting dates (53.6%), and use of flood-tolerant varieties (41.8%). Education level, extension access, household size, and cooperative membership significantly influenced mitigation behaviors.

5. Conclusion & Recommendations:

The study highlights the need for enhanced public awareness and timely dissemination of localized weather forecasts. Strengthening extension services and farmer networks will be critical in promoting proactive adaptation strategies to build climate resilience.

Keywords: Flood Risk, Mitigation Measures, Rice Farmers, Climate Adaptation, Kano State

Assessing the Economic and Food Security Implications of Climate Change in Sindh, Pakistan

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1. Introduction:

Sindh, a key agricultural region of Pakistan, is increasingly vulnerable to the adverse effects of climate change. Rising temperatures, erratic rainfall, and extreme weather events have disrupted crop cycles, reduced yields, and deepened rural vulnerabilities. Despite Sindh's vital role in national food production, its economic resilience under climate stress remains underexplored.

2. Objectives:

This study investigates the economic effects of climate change on agricultural productivity and household food security in Sindh. It also identifies key vulnerabilities and adaptation strategies among smallholder farmers to inform climate-resilient policy planning.

3. Methodology:

A mixed-methods approach was adopted, using primary data from farm-level surveys in Mirpur Khas and secondary climate records. Econometric techniques including the Ricardian model and food security indices were applied to analyze the relationships between climate variability, crop income, and household food security.

4. Results:

Rising temperatures were found to significantly reduce cotton yields and farm incomes. Households practicing crop diversification and with access to extension services reported higher food security scores. Vulnerability was particularly acute among female-headed and resource-constrained households, underscoring socio-economic disparities in climate adaptation.

5. Conclusion & Recommendations:

Climate change threatens both agricultural productivity and food security in Sindh. Targeted investments in climate-smart agriculture, institutional support, and inclusive rural policy frameworks are critical to improving resilience. The findings call for integrated strategies to align Pakistan's agricultural development with climate adaptation goals.

Keywords: Climate Change, Agricultural Productivity, Food Security, Climate Resilience, Sindh, Pakistan

Climate-Smart Agriculture: Adoption Pathways, Impacts, and Policy Implications for Sustainable Development

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1. Introduction:

Agriculture contributes over 20% of global greenhouse gas emissions and nearly 45% of methane emissions, making it both a victim and driver of climate change. Climate variability significantly affects crop productivity through soil degradation, pest outbreaks, and water scarcity—threatening global food and nutritional security. In this context, climate-smart agriculture (CSA) emerges as a transformative approach to enhance productivity, adapt to climate risks, and reduce emissions.

2. Objectives:

This study aims to: examine the adoption and effectiveness of climate-smart agriculture among smallholder farmers; assess the socio-economic and environmental impacts of CSA practices; and provide policy recommendations to support sustainable agricultural transformation.

3. Methodology:

The study employed a mixed-methods approach, combining a review of existing literature, secondary data, and expert insights to evaluate CSA adoption trends and their outcomes. Key variables include access to extension services, institutional support, education, and availability of climate-related information.

4. Results:

Findings indicate that CSA adoption enhances resilience and productivity but remains limited by institutional gaps, financial constraints, and low awareness. Prominent CSA practices include crop diversification and the use of drought-tolerant varieties. Adoption is positively influenced by access to credit, education, extension services, and timely weather forecasts. Broader implementation requires robust policies, capacity-building programs, and equitable access to resources.

5. Conclusion & Recommendations:

CSA holds significant potential to align agricultural growth with climate resilience and sustainable development goals. However, its effectiveness depends on enabling policy environments, strong institutions, and targeted financial incentives. It is critical that future international climate agreements recognize the diverse vulnerabilities of developing countries and support tailored adaptation strategies.

Keywords: Climate Change, Agriculture, Sustainability, Resilience, Policy, Climate-Smart Practices

Sustainable Resource Management and Green Economic Growth: A Global Perspective with Insights from Pakistan's Energy Sector

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1. Introduction:

As global economies confront escalating environmental challenges, the need to align economic growth with ecological sustainability has gained urgent attention. Green economic growth, defined by environmentally responsible resource use, offers a pathway to sustainable development. However, managing this transition requires evidence-based strategies for sustainable resource management.

2. Objectives:

This study aims to explore the relationship between sustainable resource management and green economic development from a global perspective. It also uses Pakistan's energy sector (2020–2024) as a focal case to evaluate how national policies and practices align with global sustainability goals.

3. Methodology:

A mixed-methods approach was employed, combining a comprehensive literature review with secondary data analysis from Pakistan's energy sector. Case studies and empirical findings from international examples were integrated to assess how different countries are implementing resource-efficient growth strategies.

4. Results:

The findings highlight that effective sustainable resource management is pivotal to fostering green economies. Key drivers include renewable energy adoption, policy incentives, and investment in eco-innovation. In Pakistan, data indicates a positive trend toward energy diversification, but challenges remain in implementation and regulatory consistency. Globally, the most successful countries combine strong governance with public-private partnerships and technology-driven interventions.

5. Conclusion & Recommendations:

Green economic growth is no longer optional but a necessary response to ecological and economic vulnerabilities. The study recommends that nations, especially developing ones, strengthen institutional frameworks, prioritize environmental governance, and foster innovation in resource management. Insights from Pakistan's evolving energy strategy underscore the importance of aligning national action with global climate goals.

Keywords: Green Economic Growth, Resource Management, Environmental Sustainability, Energy Policy, Pakistan, Global Perspective

Exploring the Socioeconomic Determinants of Early Marriages and Domestic Violence in Pakistan

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1. Introduction:

Early marriage and domestic violence are deeply entrenched social issues in Pakistan, often exacerbated by socioeconomic inequalities, cultural traditions, and limited educational opportunities. These phenomena not only violate human rights but also hinder progress toward gender equity and sustainable development.

2. Objectives:

This study aims to assess the contribution of various socioeconomic factors such as household income, education, and cultural norms to the prevalence of early marriages and their association with domestic violence among women in Pakistan.

3. Methodology:

The analysis draws on data from the Pakistan Demographic and Health Survey (PDHS) 2017–2018. Descriptive statistics and regression models were used to examine the relationship between early marriage and different forms of domestic violence, controlling for key socioeconomic and regional variables.

4. Results:

Findings reveal that 34% of women were married before the age of 18. Higher educational attainment significantly decreased the likelihood of early marriage. Regional disparities were evident, with women in Sindh and Khyber Pakhtunkhwa reporting higher rates of domestic violence compared to Punjab. Emotional violence was the most common form (reported by 45% of women), followed by 8% experiencing severe physical abuse. Early marriage showed a strong positive correlation with the incidence of domestic violence, particularly among low-income households.

5. Conclusion & Recommendations:

The results underscore the urgent need for universal access to education, financial support for vulnerable households, and community-based initiatives to challenge harmful cultural practices. Addressing the root causes of early marriage and domestic abuse is essential for promoting gender equality and achieving the Sustainable Development Goals (SDGs), particularly those related to health, education, and human rights.

Keywords: Early Marriage, Domestic Violence, Education, Socioeconomic Factors, Gender Equity, Policy Interventions

Groundwater-Dependent Agricultural Use and Economic Development: Does It Follow an Environmental Kuznets Curve?

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1. Background / Introduction

Groundwater serves as a crucial resource for agricultural production, especially in water-scarce regions such as Pakistan and India. However, the increasing reliance on groundwater raises sustainability concerns. Understanding how groundwater use evolves with economic development is essential for designing effective water governance strategies. This study applies to the Environmental Kuznets Curve (EKC) framework to explore whether the relationship between groundwater use, and economic development follows an inverted-U pattern globally.

2. Objectives

The primary objective is to assess whether groundwater use increases at early stages of economic development and declines beyond a certain income threshold, consistent with the EKC hypothesis. The study also explores how income levels influence shifts toward sustainable groundwater practices.

3. Methodology

Using cross-sectional and panel datasets, the study models the area equipped for groundwater-based irrigation as the dependent variable. GDP per capita and its quadratic term serve as key explanatory variables, along with several controls. Cross-sectional regression is initially employed to address data limitations, followed by Panel Corrected Standard Errors (PCSE) to correct for heteroskedasticity and autocorrelation. Robust checks include lagged explanatory variables and models with and without controls.

4. Results

The analysis consistently supports an inverted-U relationship between GDPs per capita and groundwater use, validating the EKC hypothesis. At lower income levels, groundwater dependency increases, but beyond a certain economic threshold, usage begins to decline, suggesting improved efficiency and adoption of sustainable practices.

5. Conclusion & Recommendations

The findings indicate that economic growth influences groundwater extraction behavior, with significant policy implications including promotion of early adoption of sustainable practices**,** investing in water-saving technologies, strengthening monitoring and institutions, aligning agricultural and water policies, ensuring equitable access, encouraging regional and international cooperation, and designing income-sensitive policies.

Keywords: Groundwater management, Agricultural sustainability, Environmental Kuznets Curve (EKC), Economic development, Water governance

Examining Industrial Eco-Efficiency in the Carbon Border Adjustment Mechanism Regime: An Empirical Analysis of South Asian Countries

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1. Introduction:

The global transition toward greener economies has brought increased focus on the European Union's Carbon Border Adjustment Mechanism (CBAM), which introduces carbon tariffs on carbon-intensive imports. This policy shift is expected to have significant implications for developing countries, particularly in South Asia, where industrial sectors are both carbon-intensive and export-oriented.

2. Objectives:

This study aims to assess the eco-efficiency of selected South Asian countries including Bangladesh, India, Pakistan, Nepal, and Sri Lanka within the evolving CBAM framework. Specifically, it evaluates how key industrial sectors targeted under the initial CBAM phase perform in terms of both resource utilization and environmental impact, while addressing the broader goal of global carbon neutrality by 2050.

3. Methodology:

The research employs Stochastic Frontier Analysis (SFA) with a Translog production function to separately measure resource efficiency and environmental efficiency. The panel dataset spans from 1990 to 2023 and includes variables such as energy use, capital, labor, CO_2 emissions, greenhouse gases, and industrial value-added. All variables are normalized and log-transformed to ensure robustness in estimation and interpretation.

4. Results:

Preliminary findings indicate regional disparities in industrial eco-efficiency, with some countries exhibiting relatively low resource use efficiency and higher environmental impact. The study is expected to identify which countries are most vulnerable to the economic consequences of CBAM, and where policy reform is most urgently needed. Final estimation results are currently in progress.

5. Conclusion & Recommendations:

This research contributes to the growing body of literature at the intersection of trade policy and environmental economics by introducing a methodological framework to assess industrial eco-efficiency in the CBAM context. The findings can inform national strategies for cleaner production and offer guidance for navigating trade competitiveness under emerging environmental standards.

Keywords: Eco-Efficiency, Resource Efficiency, Environmental Efficiency, CBAM, Translog Production Function, Stochastic Frontier Analysis

Asymmetric Association of Consumption and Production-based Carbon Emissions with Tourism Development in Pakistan

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Introduction:
Tourism in Pakistan holds immense potential for economic growth but is increasingly threatened by environmental degradation. Carbon emissions, both from domestic production and consumption, have emerged as key environmental pressures that may influence tourism patterns. This study explores the asymmetric relationship between carbon emissions and tourism development in Pakistan.

Objectives:
The study examines the asymmetric impacts of consumption-based and production-based carbon emissions on tourism development in Pakistan from 2000 to 2024, highlighting the differentiated environmental pressures influencing the sector.

Methodology:
Using ARDL and NARDL models, the research evaluates the impact of CBCE, PBCE, GDP growth, inflation, and exchange rate fluctuations on tourism development. This time-series analysis captures both short-run and long-run nonlinearities using econometric modeling techniques.

Results:
Findings support the Growth-Led Tourism Hypothesis. Economic growth positively influences tourism, while CBCE and PBCE exert asymmetric effects increases in emissions significantly deter tourism development, whereas decreases do not yield proportional improvements. Additionally, inflation and exchange rate volatility negatively impact tourism performance.

Conclusion & Recommendations:
Sustainable tourism in Pakistan requires more than just emission control, it demands integrated policy action. The asymmetric effects of carbon emissions suggest that proactive environmental regulation, promotion of eco-tourism, investment in green technologies, and macroeconomic stability are essential. Policymakers should adopt a comprehensive approach to align tourism development with long-term environmental sustainability and national SDGs.

Keywords: Tourism, Carbon Emissions, CBCE, PBCE, Economic Growth, Exchange Rate, Inflation

Governance of Potato Value Chains for Regenerative Agriculture: Pathways to Sustainability and Climate Resilience in Pakistan

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Introduction:

As climate change accelerates, regenerative agriculture offers a vital approach to restoring ecosystems, improving soil health, and ensuring sustainable food production. Integrating regenerative principles into value chain governance (VCG) strengthens climate resilience by promoting resource efficiency, equity, and sustainability. This approach is particularly relevant for input-intensive sectors such as potato farming in Pakistan, where adopting regenerative practices can reduce vulnerabilities and foster long-term environmental and economic stability.

Objectives:

This study explores the governance mechanisms shaping the potato value chain in Pakistan and assesses how these structures influence the adoption of regenerative and climate-smart practices among growers.

Methodology:

A mixed-methods approach was employed, integrating structured interviews with potato growers in Punjab alongside detailed value chain analysis. The research explored growers' engagement in diverse value chain governance (VCG) models, spot-market, modular, relational, and captive, while simultaneously assessing the extent to which they adopted regenerative agricultural practices aimed at enhancing sustainability, resilience, and environmental stewardship within the sector.

Results:

Growers engaged in captive and formal value chain governance (VCG) models showed stronger commitment to sustainability, responsibly managing crop residues, optimizing input use, and adopting climate-smart agricultural practices. Conversely, those operating within traditional spot-market structures demonstrated weaker adherence to regenerative principles. Formal VCGs proved more effective in incentivizing best practices by embedding sustainability standards, providing technical support, and fostering accountability, thereby strengthening long-term environmental and economic resilience.

Conclusion & Recommendations:

Strengthening formal contracting mechanisms between growers and buyers is vital to advancing regenerative agriculture and climate resilience in Pakistan's potato sector. Policymakers should incentivize inclusive and accountable VCG models to align private incentives with public environmental goals.

Keywords: Regenerative Agriculture, Climate Resilience, Value Chain Governance, Formal Contracts

Climate Change Adaptation and Sustainable Management of Natural Resources

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1. Introduction:

Climate change presents significant challenges to ecosystems, water availability, food security, and biodiversity, with profound implications for both environmental sustainability and economic stability. The integration of climate science with sustainable natural resource management is critical for developing adaptive and resilient systems. Climate-induced disruptions such as declining crop yields, ecosystem degradation, and increased frequency of droughts necessitate the development of flexible, proactive strategies that minimize environmental damage while fostering sustainable development.

2. Objectives:

The objectives were to: explore innovative, interdisciplinary approaches for adapting to climate change through sustainable resource management; assess the role of economic instruments and policy mechanisms in enhancing natural resource resilience; and evaluate community participation and governance models in building climate-resilient systems.

3. Methodology:

This conceptual study draws upon a comprehensive literature review of empirical research, policy documents, and climate adaptation frameworks. Case studies from various sectors (agriculture, water, energy, and forestry) are examined to identify best practices and cross-cutting themes in climate adaptation and resource management. A comparative analysis approach was used to evaluate eco-innovative strategies and governance models across different regional contexts.

4. Results:

Findings suggest that integrated approaches, combining local knowledge, technological innovation, and policy support, significantly enhance climate resilience. Projects involving reforestation, precision irrigation, and renewable energy adoption have shown to not only mitigate environmental risks but also generate economic opportunities. However, inadequate institutional coordination, lack of stakeholder engagement, and limited access to financing remain key barriers.

5. Conclusion & Recommendations:

Achieving sustainable management of natural resources in the face of climate change requires continuous innovation, inclusive governance, and strong policy support. Effective adaptation strategies must integrate scientific insights with socio-economic realities. Policymakers should promote incentive-based mechanisms (e.g., payments for ecosystem services, subsidies for climate-smart technologies), enhance institutional capacity, and prioritize community-driven solutions. Investing in climate resilience will not only safeguard ecosystems but also contribute to long-term economic development and social equity.

Keywords: Climate Change Adaptation, Natural Resource Management, Eco-innovation, Resilience, Sustainable Policies

Innovative Pathways for Climate Resilience and Sustainable Resource Use

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1. Introduction:

Climate change has transitioned from a future threat to an immediate global crisis, impacting ecosystems, economies, and communities worldwide. The global surface temperature has already increased by 1.09°C above pre-industrial levels, primarily due to human activities. The Intergovernmental Panel on Climate Change (IPCC) identifies methane largely from agriculture and fossil fuel use as the second most potent greenhouse gas after carbon dioxide. This underscores the need to rethink current models of economic development, which rely heavily on linear resource consumption and disposal.

2. Objectives:

The objectives are to: explore innovative strategies that promote climate resilience and sustainable resource use; highlight the importance of integrating circular economy principles and decarbonization into policy and planning; and examine the role of digital technologies in enhancing adaptive capacity and efficient resource management.

3. Methodology:

This study employs a qualitative review of international climate frameworks, policy initiatives, and scientific literature. Case studies from both developed and developing countries are analyzed to assess the effectiveness of resilience-building strategies and circular economy practices. Policy documents such as the IPCC reports and the European Green Deal are examined to extract actionable insights for regional implementation.

4. Results:

Preliminary analysis suggests that circular economy models, when paired with digital innovation and strong institutional frameworks, can significantly contribute to emission reductions and adaptive capacity. Countries that have invested in green technologies and public engagement mechanisms show better progress toward climate goals. However, challenges remain, including fragmented governance, limited access to finance, and technological disparities.

5. Conclusion & Recommendations:

To achieve long-term sustainability, countries must adopt inclusive, interdisciplinary strategies that integrate environmental, technological, and economic dimensions. Strengthening climate resilience should be prioritized through adaptive governance, investment in digital infrastructure, and community-led initiatives. Policymakers should promote sustainable consumption, incentivize clean technology, and support circular models that ensure equitable growth and ecological balance.

Keywords: Climate Change, Circular Economy, Greenhouse Gases, Digital Innovation, Climate Resilience, Sustainable Resource Management

Climate Change and Employment Dynamics in Pakistan: A Sectoral Investigation

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1. Introduction:

Climate change presents a critical threat to Pakistan's economic stability, particularly affecting the agriculture and industrial sectors both of which form the backbone of employment in the country. Agriculture, which engages nearly 40% of the workforce, is increasingly vulnerable to climate-induced phenomena such as droughts, floods, rising temperatures, and erratic rainfall. Similarly, industrial employment, especially in climate-sensitive sectors like food processing and textiles, is under pressure due to energy shortages, supply chain disruptions, and infrastructure damage. This study investigates the dynamic impact of climate variability on sectoral employment in Pakistan over the period 1990–2024.

2. Objectives:

The objectives of this study are to; analyze the long- and short-run effects of climate change on employment in Pakistan's agriculture and industrial sectors; assess the role of economic and demographic variables in moderating climate impacts on employment; and recommend adaptive strategies for enhancing employment resilience in climate-sensitive sectors.

3. Methodology:

The study utilizes annual time-series data from 1990 to 2024. The Augmented Dickey-Fuller (ADF) test is employed to assess data stationarity. The Autoregressive Distributed Lag (ARDL) approach is applied to estimate long-run relationships, while the Error Correction Model (ECM) is used to evaluate short-run dynamics. Diagnostic tests such as the F-bound, CUSUM, and CUSUMQ are used to confirm model stability.

4. Results:

Empirical results show that climate variables specifically rising temperatures and fluctuating rainfall have a statistically significant and negative impact on both agricultural and industrial employment. In the short run, climate shocks adversely affect employment, as confirmed by ECM results. In the long run, agricultural GDP and rural employment are positively associated with agricultural sector employment. Similarly, in the industrial sector, industrial GDP and urban population have a positive effect, despite the adverse influence of climate variables. Model diagnostics confirm overall robustness and reliability of the estimations.

5. Conclusion & Recommendations:

The study concludes that climate change poses a significant risk to employment in both agriculture and industry in Pakistan. To mitigate these impacts, the adoption of climate-smart agricultural practices and the introduction of a rural employment guarantee scheme are recommended. In the industrial sector, labor protection laws should be strengthened, and workers should be trained in climate adaptation strategies. These measures are crucial for fostering employment resilience in the face of ongoing climate challenges.

Keywords: Climate Change, Employment, Agricultural Sector, Industrial Sector, ARDL, Pakistan

Perceptions and Choices of Business Community for Tree Plantation

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1. Introduction:

Urban Pakistan is increasingly vulnerable to climate change impacts, including rising temperatures, poor air quality, and extreme weather. Tree plantation offers a cost-effective solution by enhancing carbon sequestration, reducing urban heat islands, and improving resilience. This study explores the perceptions and choices of Faisalabad's business community regarding tree plantation, highlighting their untapped potential as contributors to climate-responsive urban planning and sustainable development along key commercial corridors.

2. Objectives:

The objectives of this study are to: provide an overview of tree plantation initiatives in Pakistan; identify economic and social factors influencing business community perceptions and choices regarding urban greening; and propose policy alternatives for enhancing business engagement in tree plantation.

3. Methodology:

This study used a descriptive design, selecting five main roads in Faisalabad via the map grid method. Primary data from business owners were gathered through structured questionnaires and interviews. Perceptions, measured via a composite index, were analyzed using multiple linear regression, while multinomial logistic regression assessed choice behavior. Variables included enterprise size, owner demographics, income, education, ownership, perceived tree benefits, and awareness of tree management practices.

4. Results:

Findings show that enterprise size, income, education level, gender, and business experience significantly influence perceptions about tree plantation. Additionally, choices regarding willingness to pay for plantation were affected by ownership status, perceived benefits, tree management concerns, and perceived importance of urban greenery. Many respondents indicated willingness to financially support tree plantation initiatives if institutional facilitation were provided.

5. Conclusion & Recommendations:

The urban business community is a key but often overlooked actor in climate adaptation. Facing air pollution, heat stress, and declining walkability, their choices in tree species, irrigation, and placement reflect adaptive behavior and resource limits. This study calls for shifting from top-down plantation drives to inclusive, enterprise-sensitive strategies, promoting co-ownership and co-management of green infrastructure to make urban forestry a scalable, economically integrated climate resilience tool.

Keywords: Perceptions, Choices, Business Community, Tree Plantation, Climate Change, Urban Greening

A Study of Punjab, Pakistan's Farm Productivity in Relation to Land Consolidation and Agricultural Efficiency

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1. Introduction:

Land fragmentation is a persistent challenge in Pakistan's agricultural sector, particularly in Punjab, where average farm size has declined, leading to inefficiencies in land use and input management. This study investigates the impact of land consolidation on farm productivity and overall agricultural efficiency. By addressing how scattered landholdings affect mechanization, labor costs, and input use, the research aims to provide empirical insights into policy-driven land reforms.

2. Objectives:

The objectives of the study are to: assess the relationship between land consolidation and farm-level productivity in Punjab; evaluate the operational efficiency gains from consolidated landholdings; and identify the socioeconomic implications of land consolidation across different farm sizes.

3. Methodology:

A mixed-methods approach was employed. Quantitative data were collected from farm production surveys across four major agricultural districts including Faisalabad, Multan, Lahore, and Sargodha. Qualitative insights were gathered through semi-structured interviews with farmers, agricultural officers, and land administration personnel. Geographic Information System (GIS) mapping was used to evaluate the spatial distribution and consolidation patterns of landholdings. Descriptive statistics, regression analysis, and thematic content analysis were used to interpret the data.

4. Results:

Findings suggest that land consolidation improves farm productivity by reducing transaction costs, facilitating efficient mechanization, and improving irrigation management. Medium- and large-scale farmers experienced greater gains in yield and cost reduction due to better access to consolidation programs and financial capital. In contrast, smallholders often lacked the institutional support and land tenure security required to participate effectively. Land consolidation also contributed to better land use planning and reduced disputes over boundaries.

5. Conclusion & Recommendations:

Land consolidation has a measurable positive effect on agricultural efficiency and output in Punjab. However, without inclusive policy frameworks, smallholders risk marginalization. The study recommends strengthening institutional support for smallholder participation in land consolidation, providing legal frameworks for land reallocation and voluntary land pooling, integrate land consolidation programs with agricultural extension services and subsidies for mechanization.

Keywords: Land Consolidation, Agricultural Efficiency, Farm Productivity, GIS, Punjab, Smallholders

Solar Tube Wells: A Smart Shift for Punjab's Rice

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1. Introduction:

Agriculture is a key pillar of Pakistan's economy, employing over one-third of the labor force and contributing significantly to the national GDP. Punjab, the leading rice-producing province, heavily depends on diesel-powered tube wells for irrigation. However, escalating fuel prices, water scarcity, and energy unreliability pose serious challenges to agricultural productivity and sustainability. Given the country's substantial solar potential, photovoltaic (solar-powered) tube wells offer a promising alternative for promoting climate-resilient and cost-effective rice farming. This study compares the economic viability and resource efficiency of diesel versus solar tube wells in Punjab's rice-growing regions.

2. Objectives:

The objectives of this study are to: assess and compare the profitability of rice production under diesel and solar-powered irrigation systems; identify socioeconomic and institutional factors influencing the adoption of solar tube wells; and explore the constraints hindering solar technology diffusion in the farming community.

3. Methodology:

The study employed a comparative economic analysis between diesel and solar tube well users, using primary data from rice farmers in Punjab. Cost-benefit analysis and benefit-cost ratio (BCR) metrics were used to assess profitability. Logistic regression was applied to determine adoption determinants. Constraint analysis was conducted to identify key barriers to solar tube well uptake.

4. Results:

Farmers using diesel-powered tube wells incurred average production costs of PKR 135,451 per acre, with irrigation expenses of PKR 40,450. They achieved 39.75 maunds per acre, earning PKR 192,231 in revenue, a net income of PKR 56,781, and a BCR of 1.42. Solar-powered irrigation reduced costs to PKR 107,126, with similar yields (39.48 maunds) but higher profitability—net income PKR 83,521, BCR 1.78. Logistic regression showed education, peer influence, and social media use positively affected adoption, while large landholdings and sole dependence on farming had negative effects. Barriers included high installation costs, theft concerns, and limited incentives; dust, cloudy weather, and technician availability were minor issues.

5. Conclusion & Recommendations:

Solar tube wells present a viable alternative to diesel systems, offering long-term economic and environmental benefits. To accelerate adoption, the government should expand subsidy programs, establish community demonstration projects, and enhance extension services. Additionally, improving access to financing and leveraging digital platforms for awareness can strengthen farmer confidence in solar technology. These measures will promote sustainable irrigation, reduce carbon footprints, and improve the resilience of rice farming in Punjab.

Keywords: Solar Energy, Irrigation, Rice Farming, Benefit-Cost Ratio (BCR), Adoption Barriers, Sustainable Agriculture

Effect of Working Conditions on the Job Satisfaction of Seasonal Workers in the Sugar Industry in Jhang District

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1. Introduction:

Seasonal employment in Pakistan's sugar industry plays a vital role in rural livelihoods, especially in districts like Jhang. Despite their critical contribution to industrial operations, seasonal workers often endure poor working conditions, including lack of job security, limited benefits, and substandard facilities. These challenges can significantly influence job satisfaction and overall productivity. This study investigates the relationship between specific working conditions and the job satisfaction of seasonal workers employed in sugar mills in Jhang district.

2. Objectives:

To analyze the effect of various working conditions on the job satisfaction of seasonal workers in the sugar industry of Jhang.

3. Methodology:

A cross-sectional quantitative study was conducted using primary data collected from 200 seasonal workers across four sugar mills (50 respondents per mill) in Jhang. A structured questionnaire was administered to gather data on demographic characteristics, employment conditions, and satisfaction levels. Binary logistic regression was employed to identify the determinants of job satisfaction, categorized as satisfied vs. dissatisfied.

4. Results:

The regression model revealed that access to medical facilities, respectful behavior by senior staff, a secure work environment, and on-site housing significantly predicted higher job satisfaction. Medical facilities (Exp(B) = 24.066), respectful treatment (Exp(B) = 29.077), workplace security (Exp(B) = 6.454), and residency access (Exp(B) = 54.458) were all highly significant ($p < 0.05$). These findings underscore the importance of health, dignity, safety, and housing in shaping worker satisfaction. Conversely, factors such as long hours, abrupt termination, limited rest, and inadequate amenities showed no significant effect. The overall model demonstrated good fit and strong predictive value.

5. Conclusion & Recommendations:

The study concludes that improved medical services, respectful supervision, workplace safety, and adequate housing significantly enhance job satisfaction among seasonal sugar mill workers. Mill management and labor policymakers should prioritize these factors in workforce planning and welfare strategies. Addressing these critical areas could lead to improved worker performance, reduced turnover, and a more sustainable seasonal labor framework. Future research should explore these dynamics over time and across other regions or comparable labor-intensive sectors.

Keywords: Job Satisfaction, Working Conditions, Seasonal Labor, Sugar Industry, Jhang, Pakistan

Climate Change Adaptation in Pakistani Agriculture: Exploring the Influence of Farmers' Awareness and Adaptive Capacity

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1. Introduction:

Climate change poses a serious threat to agriculture in Pakistan, particularly for smallholder farmers who are highly vulnerable due to limited resources and low adaptive capacity. Despite the growing need for adaptation, the uptake of climate-resilient practices remains sluggish, often attributed to a lack of awareness and access to appropriate technologies. This study aims to assess farmers' awareness of climate change and identify key factors influencing their adaptive capacity in the agricultural sector.

2. Objectives:

The objectives of this study are to evaluate the level of farmers' awareness regarding climate change; identify socioeconomic and institutional factors influencing farmers' adaptation decisions; and suggest policy measures to enhance climate resilience at the farm level.

3. Methodology:

A cross-sectional survey was conducted among 280 farmers in District Vehari using a multistage sampling technique. Data were collected using a structured questionnaire developed from existing literature. The analysis employed a binary logistic regression model, and odds ratio estimates to examine the determinants of farmers' adaptive capacity.

4. Results:

The findings reveal that awareness about climate change significantly influences adaptation decisions. Key determinants of adaptive capacity include education level, access to climate information, use of modern technologies, and availability of credit facilities. The study highlights that improved access to technology and climate information strengthens adaptive behavior among farmers. Additionally, financial support mechanisms such as credit and subsidies are crucial for enabling long-term adoption of climate-resilient practices.

5. Conclusion & Recommendations:

The study concludes that enhancing farmers' awareness and strengthening institutional support are critical to improving climate change adaptation in Pakistani agriculture. Extension services, targeted education campaigns, and financial incentives should be expanded to promote climate-smart practices. Policymakers must prioritize investments in rural infrastructure, agricultural technology dissemination, and farmer training programs to build resilience and secure sustainable agricultural livelihoods in the face of climate change.

Keywords: Climate Change, Awareness, Adaptive Capacity, Climate Resilience, Smallholder Farmers, Punjab, Pakistan

Modeling the Impact of Climate and Population Dynamics on Energy Demand: A Case Study of Pakistan

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1. Introduction:

Pakistan is experiencing increasing energy demand driven by rapid population growth and rising climate variability. These factors impose significant pressure on energy infrastructure and complicate efforts to implement sustainable energy strategies. Despite their growing importance, limited empirical studies in Pakistan have examined the joint influence of climatic and demographic changes on energy consumption. This study aims to fill that gap by modeling the effects of temperature variation and population growth on energy demand, while also forecasting future energy consumption trends. The findings aim to support evidence-based energy policy in the context of climate resilience.

2. Objectives:

The objectives of this study are to: analyze the long-run and short-run impacts of climate change and population growth on energy demand in Pakistan; forecast future per capita energy consumption using time series modeling techniques; and suggest policy recommendations for sustainable energy planning in light of demographic and climatic challenges.

3. Methodology:

Time series data from 1995 to 2025 were utilized. Stationarity of the variables was tested using the Augmented Dickey-Fuller (ADF) test. The Autoregressive Distributed Lag (ARDL) model was applied to assess the long-run cointegration relationships, while the Error Correction Model (ECM) captured the short-run dynamics. The Auto-Regressive Integrated Moving Average (ARIMA) model was employed to forecast future energy demand trends.

4. Results:

The results indicate that energy demand in Pakistan is significantly influenced by increasing temperatures, population growth, and GDP per capita, both in the short and long run. ARIMA-based forecasts suggest a 22% increase in per capita energy consumption over the next decade. These results underscore the urgent need to address demographic and environmental pressures in national energy planning.

5. Conclusion & Recommendations:

The study concludes that population dynamics and climate variables are critical drivers of energy demand in Pakistan. It recommends multi-pronged policy interventions, including investment in renewable energy, climate-smart technologies, and widespread afforestation to mitigate temperature-related impacts. Population control measures, while politically sensitive, should focus on awareness campaigns and incentives, rather than coercive policies. Overall, a shift toward green energy and integrated climate-energy planning is essential to ensure long-term sustainability.

Keywords: Climate Change, Population Growth, Energy Demand, ARDL Model, ARIMA Forecasting, Sustainable Energy, Pakistan

Impact of Value Chain Participation on Smallholder Farmers' Livelihood Status: A Case Study of Pulse Growers in Punjab, Pakistan

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1. Introduction:

Smallholder farmers are central to agricultural production and rural income generation in developing countries, including Pakistan. Their participation in agricultural value chains is increasingly seen as a key driver for improving livelihood outcomes. However, despite the growing focus on value chain development, limited empirical research exists on the direct impact of value chain participation on smallholder livelihoods, particularly in the pulses sector. This study investigates the effect of value chain engagement on the livelihood status of smallholder pulse growers in Punjab, Pakistan. It specifically aims to compare the socioeconomic outcomes of participants and non-participants in pulse value chains and identify the factors that influence participation.

2. Objectives:

The objectives of this study are to: evaluate the impact of value chain participation on the livelihood status of smallholder pulse growers; identify the key factors influencing participation in pulse value chains; and explore constraints that limit smallholder farmers' engagement in value-added activities.

3. Methodology:

Primary data will be collected from pulse growers in Bhakkar and Chakwal districts using a structured questionnaire. An endogenous switching regression (ESR) model will be employed to account for selection bias and estimate the differential impact of value chain participation on farmers' livelihood indicators, including income, asset accumulation, and food security. Descriptive statistics and regression diagnostics will also be used to complement the econometric analysis.

4. Results:

Preliminary findings suggest that participation in value chains positively influences household income, access to markets, and the adoption of improved practices. Education, landholding size, extension contact, and access to credit are among the major determinants of participation. Non-participants tend to face more structural and informational barriers, limiting their access to market linkages and institutional support.

5. Conclusion & Recommendations:

The study concludes that enhancing smallholder farmers' integration into agricultural value chains can significantly improve their livelihood status. To expand participation, targeted interventions are needed, including improved extension services, farmer training programs, access to finance, and infrastructure development. These findings offer evidence-based insights for policymakers and development practitioners aiming to foster inclusive and sustainable rural development.

Keywords: Value Chain Participation, Smallholder Farmers, Livelihood Status, Pulses, Endogenous Switching Regression, Punjab

Farmers' Perceptions of the Impacts of Climate Change on Citrus Production in District Sargodha

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1. Introduction:

Climate change poses a significant threat to agricultural sustainability, particularly in regions heavily dependent on climate-sensitive crops. In Pakistan, erratic weather patterns, such as rising temperatures, irregular rainfall, and prolonged dry spells, have adversely affected citrus production. This study explores citrus farmers' perceptions of climate change and its impacts on citrus yield and quality in District Sargodha, one of Punjab's largest citrus-producing areas.

2. Objectives:

The study aims to: assess citrus farmers' perceptions of climate change and its manifestations; examine the perceived impacts on citrus flowering, fruit setting, yield, and quality; identify socio-economic and climatic factors influencing farmers' adaptation responses; and recommend practical adaptation strategies to enhance citrus farming resilience.

3. Methodology:

A stratified sampling technique was employed to survey 80–100 citrus farmers from key tehsils including Bhalwal, Kotmomin, and Sargodha. A structured questionnaire was used to gather data on farmers' observations regarding climate variability and its impact on citrus production. Statistical analysis was conducted using SPSS (Version 25), and Principal Component Analysis (PCA) was applied to identify key socio-economic and climate-related components influencing perceptions and adaptation behavior.

4. Results:

The findings reveal that most farmers attribute declining citrus yields to rising temperatures, unpredictable rainfall, and an increase in pest and disease outbreaks. Significant factors influencing perception and adaptation include education level, household size, and access to climate-related information. PCA results further emphasized the role of socio-economic attributes and access to extension services in shaping farmers' climate responses.

5. Conclusion & Recommendations:

The study underscores the importance of incorporating farmers' insights into climate adaptation policies. Recommended measures include the promotion of climate-smart agricultural practices, improved irrigation infrastructure, enhanced local extension services, and targeted educational campaigns. Strengthening farmers' adaptive capacity through localized interventions will be critical in sustaining citrus production amid increasing climate risks.

Keywords: Climate Change, Farmer Perceptions, Citrus Production, Yield Decline, Temperature, Rainfall Variability, Adaptation Strategies

Nexus Between Agriculture, Energy Use, Economic Growth, and Environmental Degradation in West Africa: An Empirical Assessment

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1. Introduction:

West Africa is confronting increasing environmental pressures driven by agricultural expansion, energy consumption, economic growth, population increase, and foreign direct investment (FDI). While the region contributes minimally to global carbon emissions, its accelerated development path raises concerns about environmental sustainability. This study empirically investigates the dynamic nexus between agriculture, economic growth (GDP), renewable and non-renewable energy consumption, FDI, population growth, and environmental degradation across 16 West African countries.

2. Objectives:

The objectives of the study are to: examine the short- and long-run causal relationships between agriculture, energy use, GDP growth, FDI, and environmental degradation; forecast future environmental trends in the region using time series models; amd provide policy-relevant insights for promoting sustainable development in West Africa.

3. Methodology:

The study applies the Autoregressive Distributed Lag (ARDL) model and the Vector Error Correction Model (VECM) to estimate both short-run and long-run relationships among the variables. The ecological footprint (EF) is used as a proxy for environmental degradation. An ARIMA model is further used to forecast future EF trends, offering predictive insights into the region's environmental trajectory.

4. Results:

The ARDL and VECM results indicate that GDP growth and energy consumption significantly increase the ecological footprint in the short run, but their long-run effects are either statistically insignificant or turn negative. Agricultural activity also contributes to higher EF in the short term but lacks a significant long-term impact. Interestingly, FDI appears to reduce environmental degradation in the long run, suggesting a potential role for green investments. Meanwhile, population growth and renewable energy consumption show statistically insignificant impacts on EF in both time horizons. ARIMA-based forecasts suggest a potential long-term decline in environmental degradation in the region.

5. Conclusion & Recommendations:

This study underscores the complex and evolving environmental challenges in West Africa, calling for integrated policy strategies that promote renewable energy adoption, enhance energy efficiency, encourage environmentally sustainable foreign investments, and rethink agricultural practices to reduce short-term ecological pressures. Aligning development efforts with climate and sustainability goals can enable policymakers to foster long-term ecological balance, resilience, and sustainable growth in the region.

Keywords:

Ecological Footprint, ARDL, VECM, Renewable Energy, Economic Growth, West Africa

Climate Resilience and Agriculture in Bangladesh

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1. Introduction:

As climate change intensifies, Bangladesh, highly vulnerable to environmental shifts, is advancing green agricultural practices to strengthen resilience and safeguard food security. The sector faces challenges such as coastal salinity, erratic rainfall, rising temperatures, and declining yields, particularly affecting smallholder farmers and coastal communities. In response, Bangladesh promotes climate-smart solutions like improved water management, crop diversification, organic farming, and eco-friendly technologies, alongside farmer awareness and resource support. This study examines the impacts of environmental change on agriculture using statistical tools, including trend analysis, Chi-square tests, and regression analysis, to assess how environmental factors influence agricultural performance and productivity, offering insights for building a more adaptive and resilient agri-food system.

2. Objectives:

The objectives of the study are to: identify key environmental factors affecting agriculture in Bangladesh; evaluate long-term agricultural trends within the country; and assess the impact of climate change on agricultural productivity and sustainability.

3. Methodology:

The study employs both qualitative and quantitative approaches. Secondary data from government reports and agricultural statistics are analyzed. Trend analysis is used to examine long-term changes in crop yields and climatic variables. Chi-square tests help determine associations between categorical environmental factors and agricultural outcomes. Regression analysis is employed to quantify the impact of specific environmental variables, such as temperature, rainfall variability, and salinity, on agricultural productivity.

4. Results:

Preliminary findings reveal significant correlations between environmental stressors and declining agricultural yields in certain regions, particularly in coastal and drought-prone areas. Salinity intrusion and irregular rainfall patterns have led to a reduction in arable land and seasonal crop failure. However, regions that adopted green agricultural practices showed relatively better resilience, indicating the positive role of climate-adaptive farming strategies.

5. Conclusion & Recommendations:

Bangladesh's agricultural sector is under increasing stress due to environmental changes, but proactive adaptation strategies, particularly green agriculture, show promising results. The government and development partners should further scale up support for climate-resilient practices, improve farmer access to climate information and technology, and invest in infrastructure for water conservation and saline-resilient crop varieties. These efforts are essential for safeguarding food security and promoting sustainable agricultural development in the face of a changing climate.

Keywords: Climate Resilience, Agriculture, Environmental Change, Trend Analysis, Salinity, Bangladesh, Chi-square Test

Economic Analysis of Cotton: A Comparison of Climate-Resilient and Conventional Practices in Multan

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1. Introduction:

Cotton production in Pakistan, particularly in Multan, has witnessed a significant decline due to multiple challenges, including conventional farming practices, climate change, and land resource degradation. Ensuring sustainable cotton production is crucial to meet the future fiber demand and support the livelihoods of smallholder farmers who form the backbone of the sector. These farmers often face constraints such as limited access to quality inputs, insufficient extension services, and a lack of technical knowledge. In response, sustainability-driven initiatives such as the Better Cotton Initiative (BCI) have been introduced to promote climate-resilient practices, enhance resource efficiency, and ensure environmentally and socially responsible cotton production.

2. Objectives:

This study compares the economic performance of Sustainable Cotton Producers (SCPs) under BCI with Conventional Cotton Producers (CCPs) in South Punjab, examining costs, yields, returns, and climate adaptation strategies. It identifies factors influencing adoption, analyzes benefits of 2G and 3G cotton varieties in sustainable systems, and offers policy recommendations to boost productivity and resilience, aiming to assess the viability and advantages of climate-resilient cotton production over traditional practices.

3. Methodology:

The study will be conducted in the Multan district, targeting both BCI-registered and non-registered farmers. Data will be collected through structured interviews and field surveys. Econometric models such as binary logistic regression, bootstrap truncated regression, and multinomial regression will be applied to examine the determinants of adoption of advanced cotton varieties. A Benefit-Cost Analysis (BCA) will be used to evaluate and compare the profitability of SCPs and CCPs. All analyses will be performed using appropriate statistical software to ensure robust results.

4. Results (Anticipated):

It is expected that SCPs will demonstrate better economic outcomes through higher yield efficiency, better input utilization, and improved resilience to climate variability. The adoption of sustainable practices is also anticipated to reduce input costs (particularly water and pesticide usage) and contribute to improved soil health and long-term profitability.

5. Conclusion & Recommendations:

This study is expected to highlight the tangible economic benefits of adopting sustainable, climate-resilient practices over conventional methods. The findings will support policymakers, extension services, and agricultural stakeholders in designing more targeted interventions to scale up sustainable cotton production. Enhanced support in terms of technical training, financial access, and input supply chains is recommended to facilitate the broader adoption of sustainable practices.

Keywords: Cotton, Climate-Resilient Agriculture, Sustainability Analysis, Cost-Benefit Analysis, Better Cotton Initiative, Multan

Aggregate and Sectoral Impacts of Climate Change on the Economy: Evidence from Panel Data of Selected Countries

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1. Introduction:

Climate change has emerged as a critical global concern, significantly influencing economic development and affecting all major sectors of the economy. This study aims to assess the impact of climate change on both aggregate and sectoral economic growth across selected countries worldwide. Specifically, it investigates (i) the overall effect of climate change on aggregate economic performance and (ii) its sector-specific impacts on agriculture, services, industry, and manufacturing.

2. Objectives:

The objectives of this study are to: examine the effect of climate change on aggregate GDP and GDP per capita; evaluate sector-wise impacts of climate change on agriculture, industry, manufacturing, and service sectors; and explore the interaction between temperature increases and economic performance across developed and developing countries.

3. Methodology:

The study uses panel data from 1990 to 2023, collected from CRU, Penn World Table (PWT), and World Development Indicators (WDI). Econometric analysis was conducted using fixed and random effects models, with the choice between them determined by the Hausman test. The models also incorporated quadratic and interaction terms to capture non-linear and differential impacts.

4. Results:

Results show GDP growth has a positive but insignificant link with climate change, while GDP per capita is positively and significantly affected. The quadratic temperature term confirms an inverted U-shaped relationship with aggregate and sectoral growth. A 1°C rise has a 0.08% greater adverse effect on developing countries. Climate change significantly impacts service sector growth but not agriculture, industry, or manufacturing rates, though value-added contributions of all sectors are significantly influenced. Human capital and population growth positively and significantly affect both aggregate and sectoral growth.

5. Conclusion & Recommendations:

The study concludes that climate change exerts heterogeneous effects across sectors and regions, with developing countries being more vulnerable. Policymakers are advised to adopt targeted mitigation and adaptation strategies, such as investment in climate-resilient infrastructure, support for sustainable agriculture, and capacity building for climate-smart industries, to reduce the adverse economic effects of rising temperatures.

Keywords:

Climate change, economic growth, GDP per capita, sectoral growth, human capital, fixed effects model, panel data, temperature impact

One Health and Climate Change: Strengthening Livestock Resilience to Zoonotic Threats in Pakistan

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1. Introduction:

The rising frequency and geographic spread of zoonotic diseases pose a growing threat in climate-vulnerable regions like Pakistan. Vector-borne and environmentally mediated zoonoses, such as Crimean-Congo Hemorrhagic Fever (CCHF), brucellosis, and Rift Valley fever, pose critical risks to the livestock sector, which is central to Pakistan's economy and food security. These threats impact humans, animals, and the environment simultaneously, necessitating a One Health approach to enhance livestock resilience and safeguard public health under changing climate conditions.

2. Objectives:

This study aims to: analyze the impact of climate variability and regional patterns on the incidence of zoonotic diseases in Pakistan's livestock sector; and propose climate-informed and integrated strategies within the One Health framework to strengthen resilience and minimize disease outbreaks.

3. Methodology:

The research employs a multi-method approach: a literature review of climate-sensitive zoonoses and disease burden in Pakistan; spatio-temporal analysis of reported zoonotic outbreaks in relation to climatic anomalies and livestock migration patterns; and case studies from selected agro-ecological zones to highlight localized vulnerabilities and adaptive practices at the community level.

4. Results:

Findings indicate a strong correlation between climatic fluctuations, particularly increases in temperature and humidity, and spikes in zoonotic disease incidence. Arid and southern regions with weak veterinary infrastructure were identified as high-risk zones. The spread of zoonoses is exacerbated by delayed outbreak detection, inadequate national surveillance systems, and poor intersectoral coordination among veterinary, environmental, and public health institutions. Community-level awareness and preparedness for climate-driven health risks were found to be minimal.

5. Conclusion & Recommendations:

Zoonotic disease threats in the livestock sector are intensifying due to climate change, demanding immediate institutional and policy interventions. Enhancing early warning systems, integrating climate data into veterinary surveillance, promoting awareness among farmers, and operationalizing the One Health framework through cross-sectoral governance are essential. These measures can collectively reduce disease burdens and improve resilience in both animal and human health sectors amid ongoing climate uncertainties.

Keywords: Climate, Livestock, One Health, Pakistan, Zoonoses

Impact of Environment, Energy, and Food Production on Pakistan's Economic Growth: A Time Series Analysis

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1. Introduction:

Sustainable economic growth remains a key objective for developing countries such as Pakistan. However, economic development is closely intertwined with environmental sustainability, energy availability, and food production. Rapid population growth has intensified pressures on natural resources, raising concerns about long-term economic stability and ecological degradation. This study aims to empirically investigate the interlinked effects of environmental degradation, energy consumption, and food production on Pakistan's economic growth.

2. Objectives:

The objectives of this study are to: analyze the long-run and short-run impact of CO_2 emissions, energy consumption, and food production on economic growth; assess the role of population growth and energy imports in influencing growth dynamics; and provide evidence-based policy recommendations for sustainable development.

3. Methodology:

The study uses annual time series data from 2000 to 2024. The dependent variable is economic growth (GDP), while the independent variables include CO_2 emissions, energy imports, access to electricity, cereal food production, and population growth. To examine both long-run relationships and short-run adjustments, the Autoregressive Distributed Lag (ARDL) model and Error Correction Mechanism (ECM) were employed following bounds testing procedures.

4. Results:

The ARDL results indicate that CO_2 emissions, electricity access, and cereal food production exert a positive and statistically significant effect on economic growth in the long run. In contrast, energy imports and population growth have a negative impact on GDP over the same period. The ECM results confirm a significant short-run adjustment mechanism, demonstrating convergence toward long-run equilibrium after short-term shocks.

5. Conclusion & Recommendations:

The findings underscore strong structural interdependencies between environmental quality, energy dynamics, food production, and economic growth in Pakistan. These insights point to the need for an **integrated policy framework** focused on: promoting clean and efficient energy use; enhancing sustainable agricultural productivity; and reducing environmental degradation through emission control. Policymakers should adopt cross-sectoral strategies that align energy and environmental policies with economic planning to ensure resilient and inclusive growth.

Keywords: Environment, CO_2 Emissions, Energy, Food Production, Economic Growth, ARDL, Time Series Analysis

Emerging Parasitic Diseases in Fish under Climate Stress: Implications for Aquatic Sustainability and Biodiversity Conservation

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1. Introduction:

Climate change is a major driver of emerging parasitic diseases in freshwater fish, altering host–parasite dynamics through rising water temperatures, shifting precipitation, salinity changes, and modified hydrodynamics. These conditions enhance the spread, life cycle completion, and pathogenicity of parasites such as protozoans, helminths, and ectoparasites. Aquaculture systems are especially vulnerable, with high stocking densities limiting escape and increasing infection risk. Thermal stress, hypoxia, and pollution-related immunosuppression further trigger outbreaks of Ichthyophthiriasis, Sanguinicola spp., Cryptosporidium, and monogeneans, particularly in tropical and temperate waters. Such infections disrupt biodiversity, weaken ecological stability, and facilitate invasive species. Consequent declines in fish diversity and productivity threaten food security, rural livelihoods, and conservation goals. Adopting a One Health approach with integrated input from parasitologists, ecologists, climate scientists, and fisheries experts is essential for adaptive disease management and the long-term sustainability of aquatic ecosystems.

2. Objectives:

The objectives of this study are to: examine the influence of climate change on the prevalence and spread of parasitic diseases in freshwater fish; evaluate the ecological and economic consequences of emerging fish parasitoses under climate stress; and propose integrated mitigation strategies using a One Health approach for sustaining fish biodiversity and aquatic ecosystem health.

3. Methodology:

This study synthesizes current literature and case studies on climate-sensitive fish parasites, focusing on changes in disease dynamics under environmental stressors. It includes spatio-temporal analysis of outbreak patterns, host–parasite interactions, and the role of environmental variables such as temperature and dissolved oxygen.

4. Results:

The analysis highlights a strong correlation between rising temperatures and the prevalence of parasitic infections in aquaculture and wild fish populations. High-risk zones include southern and tropical regions with limited veterinary oversight. Reduced fish immunity due to climate-related stress and pollution was identified as a key driver. Disruption of trophic interactions and ecosystem imbalances were also observed.

5. Conclusion & Recommendations:

Climate-induced parasitic threats to fish represent a growing concern for aquatic sustainability and biodiversity. To counter this, strengthening disease surveillance, improving water quality management, and integrating climate forecasting into fish health protocols are recommended. Collaborative research and policy integration under the One Health paradigm will be critical in protecting aquatic life and food systems in a changing climate.

Keywords: Fish Diseases, Climate Change, One Health, Aquatic Ecosystems, *Cryptosporidium*, Biodiversity, Aquaculture, Parasitic Infections

Kudzu Plant Production to Combat Erosion and Drought in Türkiye

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1. Introduction:

Kudzu (*Pueraria montana*), native to East and Southeast Asia, is a fast-growing legume valued for its agricultural, environmental, and medicinal uses. Extensively cultivated in the United States for erosion control and livestock feed, it remains underutilized in Türkiye. Kudzu prevents soil erosion, improves fertility through nitrogen fixation, and provides nutritious forage for cattle and sheep. It also offers pharmaceutical and industrial potential, including headache remedies and amino acid and antibiotic production. In Türkiye, where soil erosion and drought are major concerns, Kudzu could serve as a sustainable, climate-resilient crop, rehabilitating saline and compacted soils. Despite proven global benefits, it has yet to be integrated into Turkish agricultural or environmental strategies.

2. Objectives:

This project aims to introduce and assess the cultivation of Kudzu in Türkiye to: combat erosion and drought through rapid biomass production and soil stabilization; reduce dependence on chemical fertilizers and pesticides via natural soil enrichment and pest resistance; explore its utility in animal nutrition and industrial integration; produce high-value bioproducts such as amino acids and antibiotics locally; and contribute to low-cost, sustainable agricultural technologies and environmental improvement

3. Methodology:

The study involves the experimental cultivation of Kudzu under controlled conditions across various soil types, including saline and compacted soils. Agronomic traits such as growth rate, nitrogen-fixing capacity, and drought tolerance will be evaluated. In addition, root and leaf extracts will be analyzed for bioactive compounds with potential applications in biotechnology and pharmacology. Laboratory protocols for amino acid and antibiotic extraction will be tested for feasibility and yield.

4. Results:

Preliminary findings suggest Kudzu adapts well to Türkiye's semi-arid regions, significantly reducing surface erosion and improving soil structure. Early biochemical analyses confirm the presence of bioactive components suitable for pharmaceutical processing. Its biomass yield and forage value also demonstrate strong potential for integration into livestock feeding systems.

5. Conclusion & Recommendations:

Kudzu cultivation in Türkiye holds promise as a multifunctional solution addressing environmental degradation, agricultural sustainability, and rural economic development. It can be strategically introduced as part of national efforts to rehabilitate marginal lands, reduce agrochemical usage, and diversify income sources for farmers. Further field trials, policy support, and industrial partnerships are recommended to scale its adoption and optimize its use across diverse sectors.

Keywords: Kudzu, *Pueraria montana*, Soil Erosion, Drought Resilience, Nitrogen Fixation, Leguminous Forage, Sustainable Agriculture, Amino Acid Production, Antibiotics, Türkiye

Impact of Climate Change on Zoonotic Parasites and Public Health Concerns

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1. Introduction:

Climate change poses significant challenges to human and animal health by altering the transmission dynamics and geographic range of zoonotic parasites. Rising temperatures, shifting rainfall patterns, and habitat disruptions affect parasite lifecycles, vector populations, and host availability. In tropical and subtropical regions, these environmental changes, compounded by migration, deforestation, and urbanization, are projected to increase zoonotic disease incidence. Vector-borne parasites transmitted by mosquitoes, arthropods, and rodents are particularly sensitive to climate variability, while waterborne parasites continue to cause over 2.2 million deaths annually, alongside widespread gastrointestinal illnesses. Climate change can either enhance or disrupt transmission cycles, with heightened risks for both rural and urban populations. Increased human-animal-environment interactions demand a One Health approach, integrating veterinary, environmental, and public health measures. This review examines the influence of climate variables on zoonotic parasite epidemiology and highlights the urgency of coordinated multidisciplinary strategies to mitigate future outbreaks.

2. Objectives:

The objectives of this study are to: assess the influence of climate change on the lifecycle and distribution of zoonotic parasites; explore the relationship between environmental change, vector ecology, and parasite transmission; and highlight the importance of a One Health framework in addressing climate-linked public health risks

3. Methodology:

This is a literature-based review synthesizing data from scientific studies, WHO reports, and global climate-health monitoring databases. It integrates findings on parasitic infection patterns, vector ecology, and climatic trends affecting parasite transmission and host susceptibility.

4. Results:

The review highlights that rising temperatures and humidity increase the survival rate and reproductive efficiency of many vectors and parasites. Regions with poor sanitation and inadequate healthcare infrastructure face an amplified risk. Zoonotic parasites such as *Giardia*, *Cryptosporidium*, and vector-borne protozoa (e.g., *Leishmania*, *Plasmodium*) show strong correlations with environmental changes.

5. Conclusion & Recommendations:

Climate change is a critical driver of zoonotic parasitic diseases. To safeguard public health, there is an urgent need for early warning systems, enhanced vector surveillance, climate-resilient sanitation infrastructure, and adoption of the One Health approach. Multi-sectoral collaboration is essential for long-term mitigation and adaptation strategies that address both environmental and epidemiological challenges.

Keywords: Zoonotic Parasites, One Health Approach, Climate Change, Parasite Transmission, Global Warming, Public Health

Strengthening Cotton Extension Services: Assessing Training Needs of Extension Field Staff in Better Cotton Production of Pakistan

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1. Introduction:

Agriculture remains the cornerstone of Pakistan's economy, offering significant employment opportunities, especially in rural areas. However, increasing climate variability has posed substantial challenges to the sector, including disruptions in cotton production critical cash crops for the country. Given this context, the present study assessed the training needs of Extension Field Staff (EFS) involved in promoting better cotton production practices.

2. Objectives:

To identify and prioritize the training needs of EFS for improved cotton production in the face of climate variability, using a systematic approach across multiple agro-ecological zones in Punjab.

3. Methodology:

The study covered five cotton-growing districts, Multan, Rajanpur, Rahim Yar Khan, Bahawalpur, and Bahawalnagar, using multistage proportionate sampling to select 359 EFS from 540. The Borich Needs Assessment Model identified priority training areas, while OLS-based multiple regression analyzed factors influencing competency requirements for better cotton production.

4. Results:

Demographic analysis revealed that 43.37% of respondents were aged 20–35 years, 82.1% held an agricultural diploma, 61.71% had up to 15 years of extension experience, and 73.7% had personal farming experience. The highest Mean Weighted Discrepancy Score (MWDS) was for “summer ploughing” (9.480), followed by controlling pre-harvest losses (8.597), adoption of resistant varieties (8.408), harvesting techniques (8.335), and intercropping practices (8.314). The regression model showed strong explanatory power ($R^2 = 0.821$, $p < 0.01$). Current competency, education, and understanding of climate variability were negatively associated with required competencies, highlighting training gaps in these priority areas.

5. Conclusion & Recommendations:

The findings highlight substantial competency gaps among EFS, particularly in core agronomic practices for climate-resilient cotton production. It is recommended that targeted training interventions focus on practical crop management, adaptive climate strategies, and modern cultivation techniques. Key areas for future capacity-building include judicious fertilizer use, crop rotation, variety selection, and appropriate sowing methods. Strengthening extension services through structured training and policy support will be vital for enhancing cotton sector resilience in Pakistan.

Keywords: Agricultural Extension Services, Better Cotton Production, Climate Adaptation, Borich Needs Assessment, Training Needs, Pakistan

Bridging Risk and Response: Policy Insights from Flood-Affected Farming Communities in South Punjab

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1. Introduction:

Floods are among the most devastating natural hazards globally, and their frequency and severity have significantly increased over the past five decades, largely due to anthropogenic climate change. Agriculture remains one of the most vulnerable sectors, frequently experiencing destruction of crops, livestock losses, and damage to critical infrastructure such as irrigation systems, storage units, and transportation networks. The cumulative impact severely disrupts both input supply chains and output markets. This study investigates the socioeconomic effects of the 2022 floods in South Punjab, Pakistan, and explores how local farming communities are adapting through risk management strategies.

2. Objectives:

The objectives of this study are to: assess the socio-economic impacts of the 2022 flood events on farming households in South Punjab; analyze the determinants influencing farmers' adoption of on-farm and off-farm risk management strategies; and provide policy insights for strengthening agricultural resilience and disaster preparedness.

3. Methodology:

Primary data were collected from 150 farming households in two severely flood-affected districts, Rahim Yar Khan and Rajanpur, using a structured questionnaire. To examine the determinants of risk management strategy adoption, two multinomial logistic regression models were estimated: one for on-farm diversification strategies and another for off-farm income diversification.

4. Results:

The analysis revealed that perceived flood risk and the occurrence of pest and disease outbreaks significantly reduced the likelihood of adopting on-farm diversification strategies. In contrast, larger farm sizes and higher livestock losses were positively associated with such strategies. For off-farm diversification, key influencing factors included age, education, farming experience, monthly income, flood risk perception, and livestock losses. These findings suggest that both socio-economic and psychological factors shape farmers' adaptation behavior under climate stress.

5. Conclusion & Recommendations:

The study underscores the critical need for targeted interventions to enhance climate resilience in vulnerable farming communities. Timely access to climate and flood-related information, along with farmer education and support programs, can significantly improve the adoption of proactive risk management strategies. Strengthening institutional mechanisms for early warning systems and capacity-building in disaster preparedness will be essential for sustainable rural livelihoods under increasing climate variability.

Keywords: Agricultural Resilience, Climate Change Adaptation, Flood Risk Management, Risk Perception, Disaster Risk Reduction, South Punjab, Livelihood Strategies

Navigating Agricultural Systems for Sustainable and Resilient Food Security: Insights from Sri Lanka, Netherlands, and Ethiopia

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1. Introduction:

Global food security is increasingly threatened by climate change, economic instability, and unequal access to resources. This study explores the transformation of agricultural systems toward sustainability and resilience, focusing on climate-adaptive practices, land use reforms, and policy innovations. Through international case studies, the paper examines how different governance and technological pathways shape food system outcomes.

2. Objectives:

The objectives of the study are to: identify key factors driving sustainable agricultural transitions in diverse socio-political contexts; compare and assess the impacts of policy and technology interventions on food security and resource efficiency; and propose integrated approaches for building climate-resilient and equitable food systems.

3. Methodology:

The study employs a qualitative, comparative case study approach, analyzing three country-specific examples: Sri Lanka (fertilizer ban and its aftermath), Netherlands (controlled-environment agriculture), and Ethiopia (land tenure reforms). Data sources include academic literature, policy reports, and sustainability assessments. Thematic content analysis was used to extract key insights across environmental, social, and economic dimensions.

4. Results:

Findings highlight that abrupt, top-down policies—such as Sri Lanka's fertilizer ban—can severely disrupt agricultural productivity if implemented without institutional readiness. Conversely, the Netherlands demonstrates how investment in high-tech, resource-efficient farming enhances productivity and environmental performance. Ethiopia's land reform illustrates that tenure security significantly boosts farmer investment and sustainability practices. These case studies underline the importance of context-specific, phased transitions supported by inclusive governance and innovation.

5. Conclusion & Recommendations:

To ensure long-term food security, agricultural systems must evolve toward models that are adaptive, inclusive, and ecologically sound. Policymakers should: avoid abrupt reforms without infrastructure and stakeholder preparedness; invest in climate-smart technologies and data-driven decision-making; strengthen land tenure systems to encourage sustainable land use; and foster cross-sectoral collaboration to build resilient food supply chains. This study advocates for integrated policy frameworks that balance productivity, equity, and ecological sustainability in response to escalating global challenges.

Keywords: Sustainable Agriculture, Climate Resilience, Land Use Policy, Agricultural Innovation, Food Security, Case Study Analysis

Analyzing the Effects of Climate Change on Water Resources in Pakistan: Farmers' Perception, Awareness, and Adaptation Practices

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1. Introduction:

Climate change poses a significant threat to global water resources, and Pakistan is particularly vulnerable due to its geographic location, agrarian economy, and dependence on glacial melt-fed river systems. The country's water availability has declined sharply, with per capita water resources falling from 5,140 m^3 in 1950 to around 1,000 m^3 today, approaching the water scarcity threshold. Rising temperatures (projected to increase by 0.9–1.5°C by 2050) and erratic precipitation patterns are expected to further exacerbate water stress, with projected changes in water availability ranging from -12% to +24%. These climatic shifts directly threaten agricultural productivity, food security, and rural livelihoods, contributing to poverty, social instability, and migration pressures.

2. Objectives:

The study aims to: assess farmers' perceptions and awareness regarding climate change and its impact on water resources; identify key factors influencing their adaptation practices; and propose evidence-based recommendations for policy and practice.

3. Methodology:

A structured survey was conducted among farming households across key agro-ecological zones in Pakistan. Descriptive statistics were used to assess awareness levels, while multivariate regression models were applied to identify determinants of adaptation choices. Secondary data on water availability and temperature trends were also analyzed to contextualize farmers' responses.

4. Results:

Findings indicate that 58–75% of farmers are aware of climate change and perceive its negative impact on water availability and crop yields. Education level, landholding size, farming experience, access to climate information, and availability of extension services significantly influence awareness and adaptation. Popular adaptation strategies include changing planting schedules, adopting water-efficient irrigation practices, and diversifying crops. However, barriers such as financial constraints, limited institutional support, and fragmented policies hinder broader adaptation uptake.

5. Conclusion & Recommendations:

To ensure sustainable agricultural water use under climate stress, the study recommends strengthening climate extension services, investing in farmer training, and improving infrastructure for efficient irrigation. Government initiatives such as the Green Pakistan Program and INDC commitments must be aligned with localized needs and farmer-led innovation. Collaborative policy making that integrates community knowledge and climate science is essential for building climate-resilient agricultural systems.

Keywords: Water Resources, Farmers' Perception, Climate Adaptation, Climate Change Awareness, Mitigation, Pakistan

Eco-Friendly Biochar for Stress Mitigation and Sustainable Agriculture

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1. Introduction:

Biochar, a carbon-rich material produced through the pyrolysis of organic biomass under low-oxygen conditions, is increasingly recognized for its potential to enhance agricultural productivity and promote environmental sustainability. Traditionally used by indigenous communities to enrich soils, biochar is now central to modern research due to its ability to improve soil fertility, mitigate abiotic stresses, and sequester carbon for climate change mitigation. Field applications demonstrate benefits such as increased crop yields, improved soil structure, reduced fertilizer dependency, and enhanced moisture retention. Its porous nature aids in pollutant adsorption, nutrient conservation, and erosion control, thereby improving soil and water quality while reducing greenhouse gas emissions.

Despite its promise, widespread adoption faces challenges, including variability in feedstock, production methods, cost constraints, and potential contamination risks. Addressing these requires standardized production protocols, robust economic feasibility assessments, and policy incentives to integrate biochar effectively into sustainable and regenerative agricultural systems.

2. Objectives:

This study aims to highlight the role of biochar in mitigating environmental stresses, its integration into climate-resilient agricultural strategies, and the research and policy innovations required to harness its full potential. The objectives of this study are to: evaluate the benefits of biochar in reducing abiotic stress in crop production; assess biochar's potential for improving soil quality and water retention; and explore its contribution to sustainable agriculture and climate resilience.

3. Methodology:

A review-based approach synthesizing recent experimental findings and meta-analyses on the use of biochar in stress mitigation, soil amendment, and climate-smart agriculture. Emphasis was placed on case studies from arid and semi-arid regions where abiotic stress is prevalent.

4. Results:

The review reveals that biochar improves plant growth under stress conditions, enhances nutrient availability, and supports microbial activity in the soil. These effects contribute to better yield stability and resource efficiency. It also underscores that context-specific application (e.g., crop type, soil texture, climate) is critical for maximizing benefits.

5. Conclusion & Recommendations:

Biochar presents a promising eco-friendly solution to contemporary agricultural challenges. Its proper use can reduce input costs, improve resilience to climate extremes, and contribute to sustainable food production systems. Future research should focus on standardizing biochar quality, lowering production costs, and integrating biochar into national climate and soil health policies.

Keywords: Biochar, Abiotic Stress, Climate Resilience, Sustainable Agriculture, Soil Amendment, Carbon Sequestration, Organic Farming

The Potential of Seaweed Utilization for Blue Economy Development in Indonesia

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1. Introduction:

Indonesia, the world's largest archipelagic nation, holds vast but underutilized marine resources. The blue economy framework presents an opportunity to develop sectors like fisheries, aquaculture, tourism, and marine biotechnology sustainably. Seaweed, in particular, offers high potential for nutrition, environmental sustainability, rural livelihoods, and industrial innovation.

2. Objectives:

This study aims to assess seaweed production and utilization in Indonesia, examine its ecological, economic, and social benefits within a blue economy framework, and explore opportunities and challenges for expanding seaweed-based industries.

3. Methodology:

A mixed-methods approach was employed, including: literature review and secondary data analysis; field observations in major production regions; stakeholder interviews (farmers, processors, policymakers); SWOT and policy analysis to assess gaps and potentials.

4. Results:

Indonesia produces over 10 million tons of wet seaweed annually, mainly in South Sulawesi, Southeast Sulawesi, Nusa Tenggara, and Maluku. Over 70% is exported dried, largely to China and the Philippines. Cultivation requires no fertilizers, land, or freshwater, supports carbon sequestration, and sustains 500,000 coastal households, especially women and marginalized groups. While boosting rural income and food security, the sector faces constraints from limited processing, weak research–industry linkages, environmental degradation, and insufficient policy recognition.

5. Conclusion & Recommendations:

Seaweed offers significant ecological and socioeconomic benefits, yet its potential in Indonesia's blue economy remains underutilized. As a carbon-negative crop and nutrient-rich food, it supports climate and nutrition goals. Reliance on raw exports limits value addition. Expanding processing for functional foods, pharmaceuticals, and bioplastics, alongside policy integration, research support, and blue carbon accounting, can strengthen the value chain and position Indonesia as a global leader in sustainable ocean-based development.

Keywords: Seaweed, Blue Economy, Sustainable Development, Marine Resource, Livelihoods

The Impact of Climate Change on Agricultural Productivity and Food Security in Developing Countries

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1. Introduction:

This study analyzes climate change impacts on agricultural productivity and food security in Pakistan, India, Bangladesh, and Nepal (2000–2024) using ADF tests and ARIMA forecasting. It examines temperature, rainfall, agricultural employment, fertilizer use, and food security metrics, with projections for 2025–2029. Findings show rising temperatures reduce yields, while well-managed rainfall boosts productivity. Agricultural employment is declining, and fertilizer use is increasing, reflecting intensification. Food security indicators show gradual improvement, yet climate change remains a serious threat. The study urges climate-smart practices, improved irrigation, and supportive rural policies to enhance resilience.

2. Objectives:

The objectives of this study are to: examine the long-term effects of climate change on agricultural productivity and food security in selected South Asian developing countries; assess the role of agricultural employment and fertilizer usage in moderating these effects; and forecast future trends in food security under climate change scenarios.

3. Methodology:

The study employs a time-series econometric framework using secondary data from 2000 to 2024. Analytical tools include the Augmented Dickey-Fuller (ADF) test for stationarity, the ARIMA model for forecasting, and correlation analysis to identify relationships between climatic and agricultural variables.

4. Results:

Rising average temperatures are closely linked to declining agricultural productivity, posing a serious challenge to global food systems. In contrast, sustainable water management enhances the positive effects of rainfall on crop yields. Meanwhile, agricultural employment continues to fall, even as fertilizer usage steadily rises, reflecting shifts in farming practices. Encouragingly, food insecurity and undernourishment have shown gradual improvements in recent years, with forecasts suggesting continued progress through 2029. These trends underscore the urgent need for climate-smart agriculture, efficient resource use, and inclusive policies to ensure resilient food systems and improved nutrition outcomes worldwide.

5. Conclusion & Recommendations:

While food security in the region is improving, climate change remains a critical threat. The study recommends: accelerated adoption of climate-resilient farming techniques; investment in water-efficient irrigation systems; and policy frameworks that support rural transformation and sustainable agricultural intensification.

Keywords: Climate Change, Food Security, Sustainability, Agricultural Yield, South Asia

The Potential for Poverty Alleviation in Indonesia's Coastal Areas through Islamic-Based Seaweed Development: Issues, Challenges, and Strategic Solutions

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1. Introduction:

Despite abundant marine resources, Indonesia's coastal communities remain poor due to weak infrastructure, market barriers, and environmental decline. This study explores how integrating Islamic economic principles into seaweed farming, a low-cost, sustainable, high-value livelihood, can alleviate poverty while promoting ecological sustainability and social justice.

2. Objectives:

This research aims to assess seaweed cultivation's potential for poverty alleviation in Indonesia's coastal regions, examine the role of Islamic principles in guiding its development, and identify challenges and strategies for integrating these values into resource management.

3. Methodology:

This study uses a qualitative research design based on secondary data, including literature reviews, policy documents from governmental and Islamic institutions, and case studies from Southeast Sulawesi, South Sulawesi, and East Nusa Tenggara, analyzed thematically within an Islamic ethical framework.

4. Results:

Coastal communities face economic vulnerability from climate-sensitive livelihoods, unstable incomes, and few alternatives. Institutional gaps including restricted credit, outdated technology, and opaque markets are worsened by middlemen dominance. Pollution, climate change, and unsustainable harvesting further reduce seaweed yields. Underused Islamic financial tools, such as zakat, waqf, and sharia-compliant microfinance, could be leveraged to strengthen value chains, develop halal-certified products, enhance governance, and promote sustainability through public programs and religious education (dakwah).

5. Conclusion & Recommendations:

Islamic-based seaweed development offers a culturally relevant, economically viable path to reducing poverty in Indonesia's coastal regions. Rooted in Islamic ethics, it fosters inclusivity, sustainability, and resilience by institutionalizing Islamic finance, enhancing processing and market links, and building partnerships among religious, governmental, and private sectors.

Keywords: Seaweed, Poverty Alleviation, Islamic Economics, Coastal Communities, Blue Economy, Indonesia

Economic Analysis of Rapeseed and Mustard Production in Punjab, Pakistan: A Mode of Diversification and Sustainable Agriculture

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1. Introduction:

This study evaluates the economic viability of rapeseed and mustard cultivation in Punjab, Pakistan, with particular attention to production and marketing challenges. As essential oilseed crops used in the production of edible oils and biofuels, rapeseed and mustard serve as promising alternatives for crop diversification. In 2018, the area under cultivation for these crops in Punjab was 119.9 thousand hectares, producing 120.5 thousand tonnes. The research aimed to estimate per-acre production costs and net returns, identify key yield-determining factors, and assess major production and market constraints.

2. Objectives:

The objectives of this study are to: estimate the cost of production and net income of rapeseed and mustard per acre; identify key socioeconomic and technical factors influencing yield; and assess major constraints faced in production and marketing.

3. Methodology:

Primary cross-sectional data were collected in 2018 from 100 randomly selected farmers in the Faisalabad and Toba Tek Singh districts, which jointly cultivate 10.4 thousand hectares. A structured questionnaire was used to gather data. A multiple linear regression model was employed to analyze the impact of selected explanatory variables on yield performance.

4. Results:

The findings indicate a declining trend in area and production projections for the next seven years. The calculated benefit-cost ratio (BCR) was 1.33, with an average net return of Rs. 9,345.95 per acre. Significant yield-influencing factors included farmer age, education level, farming experience, laser land leveling, farm size, and frequency of contact with extension services. Key constraints were high land preparation costs and inefficient market payment systems.

5. Conclusion & Recommendations:

Rapeseed and mustard present viable options for crop diversification and sustainable agriculture. However, structural barriers such as high input costs and marketing inefficiencies hinder profitability. Policy recommendations include providing targeted subsidies or credit schemes to incentivize cultivation, strengthening agricultural extension services to enhance farmer knowledge and adoption of modern practices, supporting mechanization and land preparation technologies to reduce costs, and reforming market payment systems to ensure timely and fair compensation for growers.

Keywords:

Rapeseed, Mustard, Benefit-Cost Ratio, Sustainable Agriculture, Regression Analysis, Crop Diversification

Eco-Friendly Edible Films Based on Chicken Bone-Derived Gelatin and Rice Flour: A Halal-Compliant Packaging Alternative

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1. Introduction:

Conventional plastic packaging is a major contributor to environmental pollution due to its non-biodegradable nature. In response, research has shifted toward sustainable, biodegradable materials sourced from natural by-products. Gelatin, with its excellent film-forming capacity, can be extracted from chicken bone waste, an abundant, halal-compliant resource in Muslim-majority regions. Complementarily, rice flour, rich in starch and protein, enhances film structure and integrity. Its moderate amylose content and renewability make it a promising eco-friendly additive. This study investigates the development of edible, biodegradable films using chicken bone-derived gelatin and rice starch as a sustainable packaging alternative.

2. Objectives:

the objectives of this study are to: optimize the extraction of gelatin from chicken bone waste; formulate edible films using varying concentrations of rice starch; and evaluate the physicochemical, mechanical, thermal, and biodegradability properties of the films

3. Methodology:

Gelatin was extracted through acid hydrolysis using HCl, followed by thermal treatment at 90°C for 7 hours. After drying at 50°C for 24 hours, the gelatin was combined with rice starch (0%, 5%, 10%, and 15%) and glycerol (as a plasticizer). The mixtures were cast into petri dishes and dried under controlled conditions. The resulting films were analyzed for thickness, moisture content, solubility, water resistance, texture, and visual appearance. Biodegradability was tested via soil burial over a 30-day period.

4. Results:

Film thickness increased with higher rice starch content, indicating improved film density. Water resistance reached a maximum of 58.06% at 15% rice starch, while solubility decreased, suggesting better integrity in moist environments. Moisture content slightly increased due to the hydrophilic nature of starch but remained within acceptable limits. Films with 10–15% starch showed enhanced flexibility, smoothness, and reduced brittleness. All film variants completely degraded within 30 days in soil, confirming their environmental compatibility.

5. Conclusion & Recommendations:

Chicken bone-derived gelatin combined with rice starch presents a viable, halal-compliant alternative to synthetic packaging. The resulting edible films demonstrated favorable barrier properties, mechanical performance, and full biodegradability. This innovation promotes the valorization of poultry by-products and local starch sources, offering cost-effective and sustainable solutions for the food, pharmaceutical, and agricultural industries. Future research may explore antimicrobial enhancement or scalability for industrial use.

Keywords: Biodegradable edible films, Chicken bone gelatin, Rice starch, Sustainable packaging, Halal-compliant materials

Integrating Climate Resilience and Sustainable Resource Management: A Cross-Regional Analysis of Socio-Ecological Systems

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1. Introduction:

Climate change poses an escalating threat to ecosystems and communities, especially in low-income and resource-dependent regions. Rising temperatures, erratic precipitation patterns, and frequent extreme weather events are disrupting agricultural productivity, water security, and ecological balance. While adaptation strategies are increasingly acknowledged, a gap persists in aligning climate resilience with sustainable resource governance, particularly in developing countries. This study explores how integrating these approaches can improve adaptive capacity and ecological sustainability in vulnerable socio-ecological systems.

2. Objectives:

The objectives of this study are to: examine the intersection between climate resilience and sustainable resource management; identify institutional and community-level mechanisms that foster integrated adaptation strategies; and assess comparative case studies from South Asia and Sub-Saharan Africa.

3. Methodology:

A qualitative research design was employed, including a systematic review of interdisciplinary literature, analysis of regional case studies, and application of climate adaptation frameworks. Semi-structured interviews with stakeholders (e.g., policymakers, NGOs, community leaders) were conducted to understand ground-level implementation and institutional barriers.

4. Results:

Findings indicate that regions combining ecosystem-based adaptation with participatory resource governance display enhanced resilience to climate-related stressors. Key enablers include decentralized planning, strong local institutions, and community engagement. However, major barriers, such as fragmented policy coordination, insufficient funding, and weak enforcement, continue to hinder integrated approaches.

5. Conclusion & Recommendations:

Building climate-resilient systems requires more than technical fixes; it demands cohesive, multi-level policy alignment, investment in nature-based solutions, and the empowerment of local communities. Policymakers should prioritize cross-sectoral collaboration and long-term planning to bridge the gap between climate adaptation and sustainable development. This study contributes valuable insights toward achieving environmental sustainability and resilience in socio-ecological systems facing intensifying climate risks.

Keywords: Climate Resilience, Sustainable Resource Management, Adaptive Capacity, Socio-ecological Systems, Environmental Sustainability

The Role of Energy Investment in Promoting Economic Sustainability in Developing Countries: A CS-ARDL Analysis

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1. Introduction:

Reliable, sustainable energy is vital for economic development, driving industrial growth, innovation, and infrastructure. In developing countries, its impact varies by income and governance. This study examines energy investment's role in economic sustainability across 88 developing nations (1990–2022) using advanced econometric methods addressing cross-sectional dependence.

2. Objectives:

The objectives of this study are to: evaluate the short- and long-run effects of energy investment on economic sustainability; compare the impact across different income groups: low-income, lower-middle-income, and upper-middle-income countries; and assess the role of private and public-private partnership (PPP) investments in the energy sector.

3. Methodology:

The study employs the Cross-Sectionally Augmented Autoregressive Distributed Lag (CS-ARDL) model, a second-generation panel estimation technique, to handle cross-sectional dependence and heterogeneity across countries. The dependent variable is GDP per capita growth (proxy for economic sustainability). Independent variables include labor force participation rate, gross fixed capital formation, human capital index, energy investment with private participation (EIP), energy investment through public-private partnerships (EIPP), and foreign direct investment (FDI). The analysis is performed at both aggregated and disaggregated levels based on World Bank income classifications.

4. Results:

Findings show that labor force participation, capital formation, human capital, and FDI have a statistically significant and positive impact on economic sustainability across all income groups. Both EIP and EIPP contribute positively to economic growth in lower-middle and upper-middle-income countries. However, in low-income countries, these forms of energy investment have a negative impact, likely due to inefficiencies, governance challenges, or lack of absorptive capacity.

5. Conclusion & Recommendations:

Energy investment is a key driver of sustainable economic growth in developing regions, particularly when supported by public-private partnerships and private sector involvement. However, in low-income countries, the effectiveness of such investments may be hindered by institutional constraints. It is recommended that governments in these regions prioritize investments in renewable energy and build institutional capacity to attract and manage energy-sector financing. Tailored policy interventions and regional cooperation are essential to maximizing the developmental impact of energy infrastructure.

Keywords: Economic Sustainability, Energy Investment, Public-private Partnerships, Foreign Direct Investment, CS-ARDL, Developing Countries.

Silver Nanoparticles in Trematode Management: A Resource Efficient Strategy for Climate Affected Regions

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1.Introduction:

Climate change is accelerating the spread of trematode infections, notably schistosomiasis and fascioliasis, in tropical and subtropical regions such as India, Mexico, the Bahamas, the United States, Australia, and China. These diseases pose major public health challenges in climate-vulnerable, resource-limited areas, where drug resistance, poor healthcare access, and environmental degradation hinder control efforts. Schistosomiasis affects over 151 million people, mostly in Sub-Saharan Africa, causing around 12,860 deaths annually, while fascioliasis impacts 2.6–17 million globally. Silver nanoparticles (AgNPs) offer a promising, sustainable alternative, enhancing antiparasitic efficacy, enabling targeted delivery, reducing dosing frequency, and facilitating rapid diagnostics for improved disease management in endemic regions.

2. Objectives:

The objectives of this study are to: assess the efficacy of silver nanoparticles in the treatment of trematode infections; evaluate the environmental and health safety of AgNPs as an alternative to traditional antiparasitic drugs; and explore the potential of AgNPs in diagnostics and surveillance of parasitic diseases under climate stress

3.Methodology:

Silver nanoparticles (AgNPs) were synthesized utilizing a green synthesis method that included plant-based extracts to ensure environmental friendliness and cost-effectiveness. ng electron microscopy (SEM), and transmission electron microscopy (TEM) were used to characterize the nanoparticles' size, shape, surface charge, and stability. In vitro antiparasitic assays were conducted to investigate the efficacy of AgNPs against cercariae and metacercaria stages of trematodes utilizing standardized viability and motility tests.

Preliminary laboratory and field evaluations demonstrated enhanced therapeutic efficacy of AgNP-based treatments, reduced dosing frequency, and minimal environmental residue compared to conventional antiparasitic approaches. Diagnostic accuracy also improved in early-stage infections using AgNP-tagged biosensors.

5.Conclusion & Recommendations:

Silver nanoparticles represent a climate-smart, scalable, and resource-efficient solution for trematode control in regions affected by climate change. They not only improve treatment outcomes but also reduce environmental impact and operational costs. Further large-scale clinical trials and regulatory evaluation are recommended to support their safe integration into public health strategies.

Keywords: Climate change, trematode infections, nanotechnology, silver nanoparticles, schistosomiasis, fascioliasis

Social Inequalities in Adaptation to Climate Change Strategies in District Faisalabad

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1. Introduction:

Climate change stands as one of the most critical global challenges of the 21st century, with far-reaching implications for economies, ecosystems, and public health. While its impacts are universal, the capacity to adapt is often mediated by existing social inequalities. Power imbalances and socio-economic disparities shape how communities perceive and implement adaptation strategies, often leaving marginalized groups more vulnerable.

2. Objectives:

The objectives of this study are to: examine the influence of social inequality on climate change adaptation in rural communities; identify key social and economic barriers hindering adaptive capacity; and suggest policy recommendations for inclusive climate resilience strategies.

3. Methodology:

This study investigates the relationship between social inequalities and climate change adaptation in District Faisalabad, Pakistan. Using a structured questionnaire, data were collected from a randomly selected sample of 130 respondents. The research aims to explore how social conditions, economic disparities, and cultural norms influence the adoption of climate adaptation strategies.

4. Results:

Findings from the study indicate that social inequalities pose significant barriers to climate change adaptation. Most respondents identified income inequality (74.3%) as the most critical factor limiting their ability to adapt, followed closely by limited access to resources (66.9%) and power imbalances (63.8%). Unfavorable social conditions (60.8%) and restrictive cultural norms (55.4%) were also frequently cited as key impediments. Statistical analysis further confirmed a strong, positive relationship between social inequality and reduced adaptive capacity. Respondents emphasized that socio-cultural dynamics and financial constraints significantly hinder their ability to implement effective adaptation strategies, underscoring the need for more inclusive and equitable climate resilience policies.

5. Conclusion & Recommendations:

The study concludes that social inequalities not only limit adaptive capacity but also exacerbate environmental degradation. To address this dual challenge, climate policies must be inclusive, targeting vulnerable groups with affordable, accessible solutions. Public awareness campaigns, community-based training programs, and equitable resource allocation are essential to foster resilience. A robust, localized climate adaptation policy framework, supported and implemented by the government, is urgently required to ensure sustainable and equitable climate resilience in Pakistan.

Keywords: Climate Resilience, Socio-Economic Inequalities, Adaptation Strategies, Public Health, Faisalabad

Harnessing Artificial Intelligence for Agricultural Marketing: Evidence from Farmers in Faisalabad, Pakistan

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1. Introduction:

Agricultural marketing in Pakistan faces enduring challenges, including price volatility, reliance on middlemen, inadequate storage, and restricted direct access to markets. These factors erode farmer profitability, create income instability, and limit informed decision-making. The adoption of emerging technologies, particularly Artificial Intelligence (AI), presents transformative opportunities to modernize marketing systems. AI can enhance transparency, improve demand forecasting, optimize supply chain management, and stabilize prices, ultimately enabling farmers to secure better returns while fostering a more efficient, equitable, and resilient agricultural marketing ecosystem.

2. Objectives:

This study evaluates the potential of AI-powered tools in addressing key agricultural marketing issues faced by farmers in the Faisalabad district and identifies the socio-economic factors influencing their willingness to adopt digital marketing platforms.

3. Methodology:

A cross-sectional survey was conducted with 200 farmers in Faisalabad using a structured questionnaire. The data collected covered demographics, market constraints, digital literacy, and perceptions of AI. Analytical tools included descriptive statistics, Spearman's rho correlation, and binary logistic regression to identify significant predictors of AI adoption.

4. Results:

Findings revealed that farmers generally had low awareness and understanding of Artificial Intelligence (AI) tools in agricultural marketing. However, a clear majority indicated a willingness to adopt such innovations if provided with adequate training, technical guidance, and financial assistance. Key positive predictors of adoption included digital literacy, prior exposure to modern technologies, and trust in AI-generated market pricing. Additionally, both education level and smartphone ownership demonstrated statistically significant correlations ($p < 0.05$) with the willingness to adopt AI tools, underscoring the importance of targeted capacity-building initiatives.

5. Conclusions & Recommendations:

The study underscores the transformative potential of Artificial Intelligence (AI) in modernizing agricultural marketing systems, minimizing reliance on intermediaries, and ultimately increasing farm profitability. To achieve effective adoption, substantial investments are required in rural digital infrastructure, comprehensive farmer training programs, and targeted subsidies that lower entry barriers. Policymakers are urged to design and implement inclusive, farmer-centered strategies that ensure equitable access to AI tools, particularly for smallholder farmers, thereby fostering digital transformation, market efficiency, and long-term agricultural sustainability in Pakistan.

Keywords: Artificial Intelligence, Agricultural Marketing, Farmer Adoption, Digital Literacy, Policy Support, Faisalabad, Pakistan

Pulse Cultivation as an Import Substitution Strategy in Pakistan: Analyzing Farm-Level Drivers and Institutional Support

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1. Introduction:

Pakistan faces a growing challenge in ensuring food and nutritional security due to the persistent gap between domestic pulse production and national consumption. Pulses—an essential source of plant-based protein and micronutrients—are heavily imported, placing pressure on the national import bill and increasing reliance on global markets.

2. Objectives:

This study investigates the potential of enhancing domestic pulse cultivation as a strategy for import substitution. It aims to identify farm-level factors influencing pulse production and evaluate the effectiveness of institutional support mechanisms in promoting this shift.

3. Methodology:

A mixed-methods approach was adopted, combining quantitative surveys and qualitative interviews. The study analyzes variables such as landholding size, access to inputs, farmer awareness, cropping systems, and market incentives. Additionally, it assesses the role of government policies, extension services, credit facilities, and agricultural research institutions in facilitating pulse cultivation.

4. Results:

The findings reveal substantial gaps in farmer knowledge, adoption of improved technologies, and institutional coordination. Limited extension outreach and inconsistent policy support were cited as major barriers. Despite these challenges, favorable market conditions and targeted institutional interventions could significantly increase domestic pulse production.

5. Conclusion & Recommendations:

Promoting pulse cultivation through improved value chain integration, financial incentives, and tailored policy frameworks can enhance self-sufficiency and reduce Pakistan's dependency on imports. Strengthening institutional support and raising farmer awareness are critical steps toward achieving sustainable agricultural development. This study offers practical recommendations for policymakers, development agencies, and agricultural stakeholders aiming to reposition pulses as a strategic crop within national food policy.

Keywords: Pulses, Import Substitution, Institutional Support, Farm-Level Drivers, Mixed-Methods Research, Pakistan

Bridging the Gap: Governance-implementation Errors in Agriculture policy; Perspectives from Southern Punjab, Pakistan

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1. Introduction

Despite decades of reform in Pakistan's agricultural policy landscape, rural development outcomes remain suboptimal. One key yet understudied issue is the persistent governance–implementation gap, where well-designed policies fail due to institutional weaknesses and poor execution. This disconnect is particularly visible in Southern Punjab, a region rich in agricultural potential but hindered by systemic governance failures.

2. Objectives

This study seeks to: identify the political and institutional barriers to effective agricultural policy implementation; analyze specific governance failures using evidence from Southern Punjab; and contribute to the broader discourse on institutional bottlenecks undermining rural development policy across Pakistan.

3. Methodology

The study adopts a qualitative, case-based approach, drawing on secondary sources, policy papers, and contextual analysis of regional interventions. Three illustrative cases are analyzed to explore how institutional shortcomings distort policy outcomes at the ground level.

4. Results

Case studies reveal systemic failures in agricultural policy implementation. In Bahawalpur, weak verification under the Punjab Kissan Package (2016) enabled elites to capture subsidies meant for smallholders. In D.G. Khan and Rajanpur, over 450,000 farmers applied for solar tube well subsidies in 2022, but poor inter-agency coordination stalled progress. A 2021 survey showed 79.4% of vegetable farmers in Multan relied on pesticide vendors for advice, exposing the collapse of public agricultural extension services.

5. Conclusion & Recommendations

The findings emphasize that **policy design alone is insufficient** without robust institutional capacity and accountability mechanisms. Governance failures manifest through bureaucratic fragmentation, elite capture, and weak public service delivery ultimately undermining rural development. To bridge the governance–implementation gap, the study recommends:

- Enhanced decentralization of agricultural policy administration
- Transparent and inclusive implementation processes
- Strengthening farmer-oriented governance and accountability structures

Keywords: Southern Punjab, Rural Development, Governance, Policy–Implementation Gap, Institutional Failure

Balancing Agrobiodiversity and Sustainable Land Use in Pakistan's Evolving Food System

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1. Introduction

The global food system is under immense pressure to ensure equitable and sustainable access to nutritious and affordable diets for a projected population of 10 billion by 2050, requiring an estimated 70% increase in food production. However, this challenge is exacerbated by rapid urbanization, unchecked population growth, and environmentally unsustainable economic expansion. Within this context, agricultural biodiversity is essential for ecosystem resilience and long-term food system sustainability is rapidly diminishing, often due to poorly aligned policies and socioeconomic inequality.

2. Objectives

This study examines the growing tension between food production, biodiversity conservation, and land-use transformation in Pakistan. In Punjab, an estimated 20–30% of fertile land has been converted to non-agricultural use, particularly housing societies and commercial enterprises. This shift has led to the dominance of monocultures, loss of crops and livestock diversity, and a narrowing of dietary variety, ultimately threatening ecological balance and planetary health.

3. Methodology

The research is based on a review of national policy documents, satellite-based land-use change data, and secondary literature to identify policy gaps and systemic challenges influencing agrobiodiversity and land use.

4. Results

Findings highlight significant inconsistencies in land-use governance, a lack of environmental valuation in planning frameworks, and limited incentives for conservation-friendly agricultural practices. The analysis reveals that current agricultural and urban development policies inadequately address biodiversity conservation and climate resilience.

5. Conclusion & Recommendations

The study advocates for integrated policy reforms that prioritize environmental valuation, sustainable land-use regulation, and agroecological transition strategies. Recommended tools include land zoning laws, targeted subsidies, awareness campaigns on dietary diversity, and the creation of agroecological corridors. These measures are vital to developing a resilient, biodiverse, and equitable food system in Pakistan that ensures environmental and nutritional security for future generations.

Keywords: Sustainable Development, Agrobiodiversity, Dietary Diversity, Land-use Change, Food Systems

Eco-Efficient Livestock Farming: Using Parasite-Resistant Breeds for Sustainable Parasite Control

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1. Introduction:

The growing anthelmintic resistance in gastrointestinal parasites has reduced treatment efficacy, increased costs, and raised sustainability concerns. Breeding parasite-resistant livestock offers a cost-effective, eco-friendly alternative, as such animals naturally limit parasite establishment and damage while maintaining productivity. Advances in molecular genetics, QTL mapping, and genomic selection enable integration of resistance traits, reducing drug use and improving welfare. Wider adoption requires greater awareness, institutional support, and collaboration among researchers, breeders, policymakers, and producers to unlock its full potential.

2. Objectives:

To evaluate the efficacy and potential of parasite-resistant livestock breeds in reducing reliance on anthelmintics and promoting sustainable livestock production systems.

3. Methodology:

The resistance, resilience, and susceptibility of Dera Din Panah and Nachi goat breeds to internal parasites were evaluated through experimental infection using *Haemonchus contortus*, an abomasal nematode and model parasite. Animals were infected with third-stage larvae via early and late exposure modes. Over eight weeks, fecal, blood, and necropsy samples were collected and analyzed using standard parasitological, hematological, immunological, and biochemical methods. Post-necropsy assessments determined worm counts and infection establishment rates, providing insights into breed-specific parasite responses.

4. Results:

Significant ($P < 0.05$) differences between Dera Din Panah and Nachi goat breeds were observed in fecal egg count, post-necropsy worm count, infection establishment rate, packed cell volume, hemoglobin, eosinophils, FAMACHA score, serum proteins, albumin, immunoglobulins, plasma histamine, and body weight at various intervals post-infection. Nachi goats exhibited a weaker response, while Dera Din Panah showed lower egg counts, fewer recovered worms, smaller reductions in packed cell volume and hemoglobin, and higher antibody and plasma histamine levels, indicating greater resistance to *Haemonchus contortus* infection.

5. Conclusion & Recommendations:

Selective breeding for parasite resistance provides a sustainable, eco-efficient method to control livestock infections, reducing chemical use, improving welfare, and boosting profitability. Scaling adoption requires awareness campaigns, genetic research, and targeted extension programs. Strong policy and veterinary sector support is essential to integrate parasite-resistant breeding into national livestock improvement strategies.

Keywords: Anthelmintic Resistance, Selective Breeding, Sustainable Livestock Production, Parasite Management, Animal Welfare

Agri-Food System Transformation, Food Security & Market Dynamics in Pakistan

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1. Introduction

Pakistan's agri-food system is at a critical turning point, challenged by population growth, climate volatility, policy inefficiencies, and market distortions. Although agriculture employs over 37% of the workforce, more than 36% of the population suffers from moderate to severe food insecurity (FAO, 2023). Volatile markets, fragmented supply chains, and a lack of value addition further compound the issue. A transformative approach is essential, not only to ensure food security but also to promote sustainable rural development and national economic resilience.

2. Objectives

This study seeks to: analyze structural weaknesses in Pakistan's agri-food system that contribute to persistent food insecurity; examine how market dynamics including price volatility, input costs, and trade policies affect food availability and affordability; explore strategic pathways for sustainable and inclusive agri-food system transformation; and recommend policy and institutional reforms to strengthen value chains and improve governance.

3. Methodology

Using national (PBS, Ministry of Food Security) and international (FAO, WFP, IFPRI) data, complemented by key informant interviews in Punjab, Sindh, and Balochistan, the study applies a modified food systems framework. Methods include descriptive statistics, SWOT of wheat, rice, vegetables, dairy, price spread analysis, and policy impact assessment.

4. Results

Smallholders with under five acres drive Pakistan's agriculture yet face low yields, 15–30% post-harvest losses, and poor access to quality inputs, technology, and extension services. Stagnant farm-gate prices stem from inefficient markets, hoarding, flawed procurement, and policy inconsistencies. Climate shocks, heatwaves, floods, droughts, hit Sindh and Balochistan hardest, while water-intensive crops deepen resource stress. Policy incoherence and subsidies favoring large landowners hinder reform. Nonetheless, digital platforms, mobile advisories, youth enterprises, and climate-resilient farming in Punjab and Sindh signal a shift toward a sustainable, equitable agri-food system.

5. Conclusion & Recommendations

Pakistan's agri-food system needs a systemic shift toward sustainability, equity, and resilience. Priorities include replacing input-based subsidies with outcome-focused policies, investing in rural infrastructure, and empowering smallholders especially women and youth through finance, insurance, and training. Promoting climate-smart, water-efficient farming, early warning systems, and stronger, data-driven governance via multi-stakeholder collaboration will ensure long-term transformation.

Keywords: Agri-food Systems, Food Security, Market Dynamics, Rural Livelihoods, Sustainable Agriculture, Policy Reform, Climate Resilience, Value Chains

The Nutritional Outcomes of Gendered Time Poverty in Agricultural Sector of Punjab, Pakistan

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1. Introduction:

Time poverty, defined as a lack of discretionary time for rest, self-care, and leisure is an underexplored form of deprivation, especially prevalent in low- and middle-income rural economies. Women are particularly vulnerable due to their disproportionate involvement in unpaid domestic and care work alongside agricultural labor. This gendered imbalance not only reflects labor inequality but also leads to compromised well-being, particularly nutritional health.

2. Objectives:

This study examines the extent and impact of gendered time poverty in rural Punjab's agricultural sector. Specifically, it aims to: quantify and compare time use by gender in productive (paid) and reproductive (unpaid) activities; measure the prevalence, depth, and intensity of time poverty; and evaluate the impact of time allocation on dietary diversity scores (DDS) as a proxy for nutritional sufficiency.

3. Methodology:

A multi-stage stratified sampling technique was employed to select 662 respondents (both men and women) from four purposively selected districts: Faisalabad, Jhang, Toba Tek Singh, and Chiniot. Primary data were collected through semi-structured questionnaires focusing on daily time use, socio-economic characteristics, caregiving responsibilities, and dietary habits. Analytical techniques included descriptive statistics, time-use analysis, and Structural Equation Modeling (SEM) to assess relationships between gender, time poverty, and nutrition.

4. Results:

The study highlights pronounced gender disparities in time use. Men and women devote similar hours to farm work (7.40 vs. 7.58), but women spend far more on household chores (3.11 vs. 1.01) and caregiving (1.77 vs. 0.54). This leads to a total workload of 17.31 hours for women versus 10.83 for men, reducing women's time for sleep (6.31 vs. 8.30) and leisure (1.73 vs. 5.44). Time poverty affects 64.95% of participants, disproportionately women. Time Poverty Gap and Time Gap Ratio stand at 0.4675 and 0.0599. SEM analysis identifies gender as the strongest predictor of disparity (1.65), followed by education, age, and income. Unpaid chores and caregiving negatively impact dietary diversity (-0.25, -0.087), while leisure time is positively linked (0.20), underscoring the nutrition–time poverty connection.

5. Conclusion & Recommendations:

Women in rural Pakistan face a dual burden of agricultural and unpaid domestic work, leading to severe time poverty and nutritional deficits. The study emphasizes that gendered time poverty is a critical but overlooked dimension of inequality. Policy interventions should promote time-saving technologies, improve access to childcare and extension services, and integrate time use into nutrition and poverty assessments to support equitable and sustainable development.

Keywords: Time Poverty, Gendered Time Use, Unpaid Care Work, Nutritional Outcomes, Rural Pakistan

Determinants of Household Coping Strategies under Food Insecurity: Evidence from Afghan Refugees Living in Pakistan

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1. Introduction:

Food insecurity remains a critical issue among displaced populations worldwide. Afghan refugees residing in Pakistan face significant socio-economic challenges that shape their ability to respond to food shortages. Understanding how households adapt to food insecurity through coping strategies can inform targeted interventions and support services.

2. Objectives:

This study examines the socio-economic determinants influencing the adoption of household coping strategies among Afghan refugees in Pakistan in response to varying levels of food insecurity.

3. Methodology:

The research utilizes secondary data from the Health Access and Utilization Survey (2022) conducted by the United Nations High Commissioner for Refugees (UNHCR). A Reduced Coping Strategy Index (rCSI) was constructed as the dependent variable, categorizing coping behavior into four levels: no coping, least reduced coping, moderately reduced coping, and severely reduced coping strategies. A multinomial logit regression model was applied to assess the influence of socio-demographic and geographic variables on these categories.

4. Results:

The findings reveal that refugee households with larger family sizes are more likely to adopt severe coping strategies. Households with lower education levels and unstable income sources particularly daily wage laborers are more inclined to employ less severe strategies. Geographic differences were also significant: refugees in Punjab and Balochistan provinces reported higher reliance on moderate to severe coping mechanisms compared to those in other regions. Refugees who arrived after 2020 were more dependent on basic coping strategies than those who arrived earlier. Moreover, those residing in camps exhibited greater vulnerability and were more likely to rely on coping strategies than refugees living in urban or rural non-camp settings.

5. Conclusion & Recommendations:

The study underscores the need for targeted interventions aimed at improving education and employment opportunities for Afghan refugees, particularly those in high-risk provinces and camp settings. Tailored policy support at the provincial level, combined with community-based resilience strategies, can help reduce the dependence on negative coping mechanisms and improve food security outcomes for this vulnerable population.

Keywords: Coping strategies, Reduced Coping Strategy Index (rCSI), Food insecurity, Afghan refugees, Displacement

The Role of Women in Ensuring Domestic Food Security in Rural Communities: A Comparative Study of Punjab, Pakistan

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1. Introduction:

Domestic food insecurity remains a major challenge in many developing nations and has become a central concern in national economic and social policies. In rural Pakistan, women are deeply involved in food production, preparation, storage, and resource management. However, their vital contributions as food producers and providers often remain underrecognized in policy and practice.

2. Objectives:

This study aims to investigate and compare the roles of rural women in ensuring household food security across different agro-ecological zones of Punjab, Pakistan.

3. Methodology:

A cross-sectional survey design was employed, collecting primary data from 420 rural households across three districts: Chakwal (North Punjab), Faisalabad (Central Punjab), and Vehari (South Punjab) using a structured interview schedule and simple random sampling.

4. Results:

Food security levels varied by region: 60.7% of households in North Punjab were food secure, compared to 52.2% in Central Punjab and only 40.0% in South Punjab. The study found that 67% of rural women were engaged in food production as laborers. In terms of food access, 23% contributed through income-generating activities and 57.4% were responsible for food purchasing. Regarding food utilization, 77% of women were involved in food preparation and distribution within households. However, only 15.2% of all women demonstrated high awareness of nutritional food, regionally, this awareness was lowest in South Punjab (7.9%), moderate in Central Punjab (16.4%), and highest in North Punjab (21.4%).
Binary logistic regression analysis showed that female education, income contribution, decision-making authority, and control over financial resources had a significant positive association with household food security. In contrast, larger family sizes and older age were negatively associated with food security outcomes.

5. Conclusion & Recommendations:

The findings underscore the central role of women in food security at the household level, particularly in production and utilization. To improve food security in rural communities, it is essential to invest in women's education, provide training, enhance access to income-generating opportunities, and ensure equitable resource distribution.

Keywords: Women, Food Security, Rural Households, Gender Roles, Punjab, Pakistan

Gendered Pathways to Household Food Security: A Comparative Study of Women's Roles in Rural and Urban Households in Punjab, Pakistan

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1. Introduction:

This study explores the gendered pathways to household food security by comparing women's roles in rural and urban households in Punjab, Pakistan. Women contribute significantly to household food security through food production, acquisition, preparation, and distribution. However, their efforts are often underappreciated due to entrenched patriarchal norms, socio-economic inequality, limited access to education, financial resources, land ownership, and restricted decision-making authority.

2. Objectives:

The study aims to systematically examine how gendered roles and resource access influence food security outcomes in both rural and urban settings of Punjab.

3. Methodology:

Quantitative research design was employed. Primary data were collected from 384 married women using structured interview schedules. A stratified sampling approach ensured equal representation from rural and urban households. The study was conducted in three purposively selected districts of Central Punjab, chosen for their demographic and socio-economic diversity. Statistical analysis was carried out using SPSS, including both descriptive and inferential techniques.

4. Results:

Findings revealed significant differences in food security determinants across rural and urban contexts. Urban women generally had greater access to education, income-generating activities, and food markets, positively influencing their household food security. In contrast, rural women were more engaged in agricultural production but faced greater barriers, including limited mobility, lower educational levels, and reduced control over financial and household resources. A strong positive association was observed between women's involvement in household decision-making and improved food security across both settings.

5. Conclusion & Recommendations:

By highlighting structural and cultural inequalities that shape gendered experiences in food access and decision-making, this study underscores the importance of gender-responsive food security policies. The findings offer critical insights for designing context-sensitive interventions that empower women and enhance household food security in both rural and urban Pakistan.

Keywords: Gendered Pathways, Household Food Security, Rural-urban Comparison, Women's Empowerment, Punjab, Pakistan

Innovative Carbon Sources in Biofloc Technology: Enhancing Tilapia Growth, Immune Response, and Nutrient Recycling

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1. Introduction:

This study evaluated the effectiveness of different carbon sources, molasses (T0), tapioca powder (T1), and jaggery (T2), on biofloc formation, water quality, and growth performance of Nile tilapia (*Oreochromis niloticus*) fingerlings within a biofloc system.

2. Objectives:

The main objectives were to: assess the role of carbon sources in biofloc and nutrient development; evaluate their impact on fish growth, immune response, and stress tolerance; and identify cost-effective carbon inputs for sustainable aquaculture practices.

3. Methodology:

A 60-day experimental trial was conducted in 100-liter glass aquariums, each stocked with 20 tilapia fingerlings (mean initial weight: 4.5 g). A constant C:N ratio of 15:1 was maintained through aeration. Water quality parameters were monitored weekly. Growth performance indicators—including weight gain, specific growth rate (SGR), feed conversion ratio (FCR), and feed efficiency ratio (FER)—were recorded. Additionally, fish body composition and recovery from *Aeromonas hydrophila* infection were evaluated. Data were analyzed using ANOVA.

4. Results:

Tapioca powder (T1) yielded the best outcomes, including the highest weight gain (45.48%), SGR (0.15%/day), and FER (0.54), along with reduced ammonia and nitrite levels. Jaggery (T2) showed the weakest performance, likely due to slower microbial activity. All treatments achieved a 100% survival rate; however, only T1 demonstrated complete recovery from bacterial infection. Proximate analysis revealed superior crude protein (18.00%) and fat content (8.00%) in T1, indicating enhanced nutrient assimilation.

5. Conclusion & Recommendations:

Tapioca powder emerged as the most effective carbon source for improving growth performance, water quality, and immune response in biofloc-based tilapia culture. Conversely, jaggery may require optimized microbial formulations or adjusted C:N ratios for effective use. These results offer actionable insights for the sustainable development of aquaculture systems, underscoring the importance of selecting appropriate carbon sources for improved productivity and environmental health.

Keywords: Biofloc Technology, Sustainable Aquaculture, Immunostimulant, Carbon Source, Tilapia, Water Quality

Invisible Economies: Rural Women's Food Decision-Making and Household Security in Agrarian Punjab, Pakistan

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1. Introduction:

In the agrarian regions of Punjab, Pakistan, rural women play a vital yet often unrecognized role in ensuring household food security. Their food-related decisions represent a complex negotiation between cultural expectations, economic limitations, and nutritional demands.

2. Objectives:

This qualitative study, grounded in behavioral economics, aims to explore how rural women make food-related decisions while navigating structural inequalities and psychological constraints.

3. Methodology:

The research is based on in-depth interviews and focus group discussions with 45 women from three rural districts in Punjab. It examines the cognitive processes, social pressures, and informal economic strategies that shape women's food management practices in resource-scarce households.

4. Results:

The findings reveal that women employ various adaptive strategies rooted in behavioral patterns such as mental accounting, scarcity framing, and present bias. Decision-making is driven not only by the availability and affordability of food but also by a moral responsibility to safeguard the health of family members, especially children, while maintaining household harmony and dignity. Common coping strategies include rationing, ingredient substitution, reliance on local social networks, and self-sacrifice through deferred consumption. Despite limited control over household finances, rural women demonstrate considerable agency, resilience, and ingenuity in food provisioning functioning as "invisible economists" within the home. However, their decision-making capacity is often constrained by entrenched gender norms, low literacy rates, and the absence of institutional support.

5. Conclusion & Recommendations:

This study underscores the need to integrate gendered behavioral insights into food security policies and rural development programs. Recognizing the economic rationality and invisible labor of rural women is essential to designing inclusive and effective interventions. The research contributes to an evolving discourse on the intersection of gender, food security, and behavioral development in South Asia, advocating a shift from welfare-based approaches to empowerment-driven strategies.

Keywords: Invisible Economies, Rural Women, Food Decision-making, Household Food Security, Behavioral Economics

Nutritional Profiling and Eating Habits of the Pakistani Population: A Two-Decade Data Analysis (1998–2019)

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1. Introduction:

Pakistan is facing a nutritional syndemic driven by obesity, malnutrition, and climate change. Malnutrition manifests as both undernutrition and overnutrition, yet comprehensive data on the nation's dietary patterns remain scarce. This study aims to bridge that gap by profiling eating habits and nutrient intake trends over the past two decades.

2. Objectives:

The study analyzes long-term consumption trends and nutritional profiles of the Pakistani population from 1998 to 2019, examining associations with socioeconomic, demographic, and household-level factors.

3. Methodology:

Secondary data from the Household Integrated Economic Survey (HEIS)/Pakistan Social and Living Standards Measurement (PSLM) were used. Consumption data across 11 food groups were evaluated using the GIFT methodology and the coefficient of variation (CV), covering all four provinces, 32 divisions, and several household variables including education, income, and gender roles in decision-making.

4. Results:

The findings highlight notable shifts in dietary patterns across income groups. Wheat consumption declined by 18.5% in the lowest quintile and 34% in the highest, while milk intake increased from 4.4L to 11.8L per capita per month. Chicken intake doubled, and potato consumption rose by 60% among poorer households, though fruits remained under-consumed in lower-income groups. Across all quintiles, steep increases were observed in fruit juices (500%), carbonated drinks (460%), sweets (120%), and commercial foods (700%). Cereals remained dominant, contributing 49% of energy, 51% of protein, and substantial B vitamins and phosphorus. Micronutrients like vitamin A, vitamin C, zinc, and iron were primarily sourced from animal-based foods and vegetables. Consumption patterns were shaped by income, gender, education, employment, family size, and ICT access, while staples like potatoes and tea showed stability.

5. Conclusion & Recommendations:

This study provides a comprehensive baseline on evolving food consumption patterns in Pakistan. Continued research is essential to understand shifting nutritional behaviors across socio-economic groups. Evidence-based food policy and targeted educational interventions are needed to address growing public health challenges and promote balanced dietary practices.

Keywords: Eating habits, food consumption trends, Pakistani diet, socioeconomic factors, nutrition profiling, food security.

Behavioral, Psychological, and Socioeconomic Determinants of Food Literacy among White-Collar Workers in Vehari, Pakistan

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1. Introduction:

Food choices in semi-urban settings are shaped by factors such as convenience, availability, behavioral tendencies, and socioeconomic conditions. Among white-collar professionals, unhealthy dietary habits and limited food literacy are linked to rising health concerns and reduced workplace productivity. Understanding the factors that influence food literacy is crucial for promoting better nutrition and well-being in this segment of the population.

2. Objectives:

This study aims to examine the behavioral, psychological, and socioeconomic factors that affect food literacy among white-collar employees in Vehari District. It specifically investigates how health awareness, income, self-efficacy, and access to information contribute to food-related knowledge and decision-making.

3. Methodology:

A structured questionnaire based on a five-point Likert scale was administered to a sample of 400 white-collar workers employed in education, banking, health, and administration sectors. The dependent variable, food literacy, was measured through self-reported awareness and food choice behavior. Independent variables included income level, educational background, self-efficacy, and health consciousness. Binary logistic regression (logit model) was employed to assess the significance and strength of the relationship between predictors and food literacy outcomes.

4. Results:

The findings indicated that health consciousness and self-efficacy were positively and significantly associated with food literacy ($p < 0.05$). Participants with higher educational attainment and income levels were also more likely to demonstrate food-literate behavior. However, accessibility and convenience were dominant influencers in food choice, occasionally overriding nutritional awareness. Psychological factors such as motivation and perceived control played a moderating role in shaping healthier food behaviors.

5. Conclusion & Recommendations:

The study concludes that food literacy among white-collar workers in Vehari is strongly influenced by a combination of psychological and socioeconomic factors. Targeted interventions such as workplace nutrition seminars, awareness campaigns, and behavioral nudges can enhance food literacy and promote healthier choices. Policymakers and employers should prioritize education-based and motivational strategies to bridge knowledge gaps and encourage long-term dietary improvements among urban professionals.

Keywords: Food Literacy, White-collar Workers, Behavioral Determinants, Socioeconomic Status, Logit Regression, Vehari District

Determinants of Household Demand for Value-Added Chickpea Products in Pakistan

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1. Introduction:

This study investigates the determinants of household demand for value-added chickpea products in Faisalabad, Pakistan. Despite chickpeas being a key dietary staple, the market for their processed forms remains underdeveloped. Understanding consumer preferences and willingness to pay (WTP) is essential to promote diversification and value addition in pulse markets.

2. Objectives:

The primary objectives of the study are to: examine household demand for various value-added chickpea products; assess awareness levels regarding these products; and estimate consumers' WTP for selected processed chickpea items.

3. Methodology:

A structured questionnaire was administered to a random sample of 110 households in Faisalabad. Data were analyzed using the Contingent Valuation Method (CVM) to elicit WTP for products such as canned chickpeas, *besan* (gram flour), *pakora* mix, *pakoria*, and ready-to-eat chickpea snacks. A Double Hurdle Model was employed: the first stage (Probit model) assessed the likelihood of WTP, and the second stage (truncated regression) analyzed the amount households were willing to pay.

4. Results:

Descriptive statistics showed that the average respondent age was 27 years, with a mean household size of 5–6 members. The average WTP was PKR 310.4 per kilogram. Income (on a 1–4 scale) averaged 2.3, indicating a predominance of middle-income households. The Probit results revealed that higher income, male gender, and being the primary household decision-maker significantly increased the probability of WTP. Conversely, concerns about product quality and availability negatively impacted WTP. In the truncated regression, income remained a significant positive predictor of the amount willing to be paid, while quality and availability concerns continued to show negative effects.

5. Conclusion & Recommendations:

The study highlights key factors influencing both the decision to purchase and the intensity of demand for value-added chickpea products. Findings underscore the need for targeted interventions such as improving product quality, ensuring consistent availability, and raising consumer awareness to boost market development for processed pulses. The integration of CVM and the Double Hurdle Model proves effective in understanding consumer behavior in emerging food markets, providing actionable insights for policymakers and agribusiness stakeholders.

Keywords: Household Demand, Value-added Products, Chickpeas, Willingness to Pay, Double Hurdle Model

Enhancing Data Literacy for Effective Foreign Trade of Agricultural Products

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1. Introduction:

Data analysis is a critical methodological tool for evaluating the efficiency and performance of agricultural production, marketing, and foreign trade. Both primary data collected from producers, marketers, traders, and consumers and secondary data sourced from national and international databases play a vital role in shaping trade-related policies. A growing reliance on data-driven decision-making highlights the importance of enhancing data literacy, especially in agricultural trade.

2. Objectives:

This study aims to: increase awareness of the availability and use of agricultural trade datasets; and explain the application of key trade measurement tools. It provides theoretical and practical insights, using Turkish agricultural markets and trade flows as illustrative examples.

3. Methodology:

The research employs international datasets from FAO, UN COMTRADE, and Eurostat, complemented by national statistics from the Turkish Statistical Institute (TurkStat). It provides a systematic approach to accessing, processing, and analyzing these diverse data sources. By integrating global and national data sets, the study enhances the reliability of findings and demonstrates their practical application in agricultural policy and trade analysis.

4. Results:

Key agricultural trade indices are systematically computed and interpreted to evaluate trade performance across commodities and markets. These include the Balassa Index, Lafay Index, and Export Performance Index, which capture comparative advantages, competitiveness, and export strength. Furthermore, concentration and diversification indices are applied to analyze market dependence and product variety. Together, these indicators provide an empirical foundation for assessing structural strengths and vulnerabilities in agricultural trade, offering robust quantitative insights to guide evidence-based policy formulation and strategic decision-making.

5. Conclusion & Recommendations:

This research advances both the understanding and practical application of trade data analysis tools, illustrated through empirical examples from Türkiye's agricultural markets. It emphasizes the importance of strengthening data literacy and analytical capacity among researchers, policymakers, and trade stakeholders. By demonstrating the effective use of indices and international data platforms, the study promotes evidence-based decision-making, supports more coherent and forward-looking trade policies, and ultimately contributes to building a competitive, diversified, and resilient agricultural sector in Türkiye and beyond.

Keywords: Agricultural Trade, Data Analysis, Trade Indices, Türkiye, Policy Tools

Digital Connectivity and Agricultural Output: The Influence of Internet Access and Smartphone Usage on Grain Production in Advanced 5G Economies

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1. Introduction:

Digitalization is a transformative force of the 21st century, reshaping various sectors, including agriculture. Globally, innovations such as real-time weather forecasting, precision farming, and dynamic market intelligence are recognized for their capacity to enhance communication, improve productivity, foster market integration, and facilitate more efficient financial and knowledge flows. Among these, internet connectivity and smartphone access play a pivotal role in enabling data-driven decision-making on farms.

2. Objectives:

This study investigates the impact of digital connectivity, specifically internet penetration and smartphone usage on grain production in five leading economies characterized by advanced 5G adoption. The analysis also considers additional factors such as cultivated land area, fertilizer application, and the agricultural labor force, using panel data from 2004 to 2021.

3. Methodology:

To capture the heterogeneous effects across the production distribution, the study employs the Simultaneous Quantile Regression (SQR) approach, offering a robust and nuanced understanding of variable influences at different levels of agricultural output.

4. Results:

Findings reveal a consistently positive effect of internet and smartphone access on grain production across all quantiles, underscoring the productivity-enhancing potential of digital technologies. Conversely, cultivated land area shows a negative association with output, especially at higher quantiles possibly due to land degradation or diminishing returns. Fertilizer use exhibits a strong and increasing positive impact across all production levels. The contribution of the agricultural labor force is more variable, with reduced significance in high-output regions, suggesting a shift toward technology-intensive farming.

5. Conclusion & Recommendations:

The results highlight the strategic importance of digitalization in driving agricultural productivity and resilience. Policymakers in digitally advanced economies should prioritize investments in rural internet infrastructure and promote smartphone accessibility to harness agriculture's untapped potential. A digitally connected agricultural sector is not only more efficient but also more adaptive to climate and market uncertainties.

Keywords: Grain Production, Smartphone Usage, Digitalization, 5G Economies, Simultaneous Quantile Regression

Socioeconomic Factors Affecting the Dietary Diversity Score of Children Aged 2–5 Years in District Vehari

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1. Introduction:

Dietary diversity is a key indicator of nutritional adequacy, particularly for children aged 2–5 years, where proper nutrition is vital for physical growth, cognitive development, and overall well-being. Socioeconomic and demographic factors such as maternal education, child's age and gender, household income, food expenditures, maternal employment, number of young children, media exposure, and urban-rural residence play a significant role in shaping children's dietary habits.

2. Objectives:

This study aims to assess the Dietary Diversity Score (DDS) among children aged 2–5 years in District Vehari and to identify the key socioeconomic factors influencing their dietary diversity.

3. Methodology:

Primary data were collected from 300 mothers of children aged 2–5 years, using a well-structured questionnaire and multistage sampling technique. The sample included an equal number of respondents from rural (150) and urban (150) areas. A logit regression model was employed to estimate the effect of various socioeconomic factors on DDS.

4. Results:

The regression analysis revealed that maternal education, child's age, child's gender, and household food expenditure had a statistically significant and positive impact on dietary diversity. In contrast, maternal employment and the number of children in the 2–5 age group showed a significant negative association with DDS. Other factors such as maternal age, paternal education, household size, urban residence, and distance to the nearest market were found to have a negative influence, while media exposure positively contributed to higher dietary diversity scores.

5. Conclusion & Recommendations:

The study concludes that maternal education plays a crucial role in shaping children's dietary patterns. Increased food expenditure is also positively associated with better dietary diversity. Public health interventions should focus on raising parental awareness regarding the importance of diverse diets that include essential food groups such as meat, dairy, fruits, and vegetables. Dietary Diversity Score (DDS) serves as a simple yet effective tool to assess and monitor children's nutritional status.

Keywords: Dietary Diversity Score, Socioeconomic Factors, Child Nutrition, Food Groups, Malnutrition, Vehari

Socioeconomic Characteristics of Household Cooked Food Waste in Urban Vehari, Pakistan

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1. Introduction:

Food waste, particularly of cooked food, presents a growing challenge in urban settings, where dietary habits, rising incomes, and cultural norms contribute to excessive consumption and loss. In developing countries like Pakistan, where food insecurity coexists with food surplus in certain households, understanding the socioeconomic determinants of food waste is essential for designing effective policy interventions.

2. Objectives:

This study aimed to examine how income, education, and other household characteristics influence decisions related to cooked food waste among urban households in District Vehari, Pakistan.

3. Methodology:

Primary data were collected from 300 urban households using a structured questionnaire. The study focused on waste behaviors concerning commonly consumed cooked food items, chicken, beef, mutton, and rice, both at home and in restaurant settings. Descriptive statistics were used to summarize trends, while logistic regression analysis was applied to identify the key predictors of food waste and food-saving behaviors.

4. Results:

Findings revealed that income and education significantly influenced food waste patterns. Households in the medium-income bracket were more likely to conserve food at home, whereas higher-income households reported greater food waste in restaurant settings. Lower educational attainment was associated with more cautious food practices at home, while individuals with higher education tended to waste more food when dining out. Gender and age also played a role: women exhibited more responsible food behaviors than men, and older respondents tended to waste less food than younger ones. Additionally, smaller household sizes and rising food prices were linked to reduced food waste. Cultural practices related to hospitality, limited awareness about the consequences of food waste, and poor knowledge of food storage techniques further exacerbated the problem.

5. Conclusion & Recommendations:

The study highlights the need for targeted educational and behavioral interventions to reduce cooked food waste, particularly in urban settings facing rising consumption and persistent food insecurity. Awareness campaigns, community engagement programs, and school-based food literacy initiatives could be effective in addressing the root causes of food waste. Policymakers should also consider integrating food-saving incentives into broader urban food security strategies.

Keywords: Cooked Food Waste, Income, Education, Gender, Family Size, Food Prices, Food Behavior, Urban Households, Logistic Regression, Vehari, Pakistan

From Farm to Fast Food: Exploring the Agri-Food Transition in Shaping Lifestyle in Pakistan

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1. Introduction:

Pakistan's agri-food system is rapidly transforming, with traditional, nutrient-rich diets increasingly replaced by ultra-processed and fast foods. This dietary shift is fueling the rise of non-communicable diseases (NCDs) such as diabetes, obesity, and hypertension. Driven by urbanization, globalization, rising incomes, and changing food markets, these trends are reshaping consumption patterns across both rural and urban areas. This study examines how agri-food transitions influence dietary behaviors and contribute to growing public health challenges.

2. Objectives:

The objectives of this study are to: explore the nature and extent of the agri-food transition in Pakistan; examine the relationship between fast food consumption and lifestyle-related health issues; identify socioeconomic and market drivers shaping food choices in rural and urban contexts; and propose policy recommendations that encourage healthier and more sustainable dietary patterns.

3. Methodology:

A cross-sectional survey of 200 rural and urban respondents used structured questionnaires to capture dietary habits, food access, health status, and socioeconomic characteristics. Data were analyzed through descriptive statistics and correlation methods to assess relationships between fast food consumption and health indicators, including BMI, reported conditions, and physical activity.

4. Results:

Findings revealed a significant correlation between fast food consumption and increased incidence of obesity, diabetes, and hypertension. Urban respondents exhibited higher rates of fast-food intake and reported more frequent lifestyle-related health problems. Key influencing factors included income level, time constraints, aggressive fast-food marketing, and limited awareness of nutritional values. Policy gaps, such as inadequate food labeling regulations and lack of public awareness campaigns, further exacerbate unhealthy food choices.

5. Conclusion & Recommendations:

The study concludes that the agri-food transition is a critical contributor to the rise in non-communicable diseases in Pakistan. Fast food consumption, driven by socioeconomic and market dynamics, is reshaping public health outcomes. The paper recommends targeted policy interventions such as mandatory food labeling, public health awareness campaigns, nutrition education in schools, and stricter regulations of fast-food advertising. Promoting sustainable diets and preserving traditional food systems are essential steps toward reducing the health burden of lifestyle diseases and achieving food system resilience.

Keywords: Agri-food Transition, Fast Food Consumption, Non-communicable Diseases, Lifestyle Health Risks, Dietary Behavior

Development of "Aquanut Delight": A Nutraceutical Chocolate Incorporating Water Chestnut Powder for Menstrual Discomfort Relief

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1. Introduction:

This research introduces *Aquanut Delight*, a nutraceutical chocolate formulated to alleviate menstrual discomfort, particularly dysmenorrhea, in women. Unlike conventional chocolates, this product is designed not only for indulgence but also for therapeutic benefits. The key functional ingredient is water chestnut (*Trapa natans*) powder, recognized for its anti-inflammatory and antispasmodic properties that can help relieve menstrual cramps. The chocolate blend includes organic, health-promoting components that also function as mood enhancers, aiming to support women's well-being during menstruation.

2. Objectives:

This research aims to: develop a nutraceutical chocolate product enriched with water chestnut powder; evaluate its physical, chemical, and functional properties; and explore its potential in alleviating symptoms associated with menstrual discomfort.

3. Methodology:

Aquanut Delight was prepared using a controlled formulation combining cocoa solids, sweeteners, fats, and organic additives, including water chestnut powder. The product was subjected to physicochemical analysis to assess Moisture content (0.01%); Ash content (2.5%); Water activity (0.5). Additional assessments included texture analysis (firmness: 31), color measurement, sugar content (10.5 °Brix), pH (neutral), centrifugation tests for stability, and preliminary phytochemical screening to verify functional compounds.

4. Results:

The results indicate that the formulation maintained desirable moisture and water activity levels, ensuring shelf stability. Texture and color parameters were within acceptable sensory thresholds. Phytochemical tests confirmed the presence of bioactive compounds potentially responsible for anti-cramping and mood-enhancing effects. The product's neutral pH and moderate sugar content contribute to palatability and consumer acceptance. The use of water chestnut not only added nutritional value but also enhanced the product's therapeutic potential.

5. Conclusion & Recommendations:

Aquanut Delight offers a novel, functional food option that aligns indulgence with health benefits. It demonstrates potential in addressing dysmenorrhea naturally while providing emotional comfort. Future recommendations include conducting sensory evaluation trials and clinical validation studies to assess consumer acceptability and efficacy in reducing menstrual symptoms. The product highlights the scope of incorporating local, underutilized functional ingredients like water chestnut in value-added food innovation targeting women's health.

Keywords: Nutraceutical Chocolate, Dysmenorrhea Relief, Water Chestnut Powder, Women's Health, Mood Enhancement, Functional Foods, Organic Blend, Food Innovation, Chocolate Formulation

Impact of Withania coagulans (Paneer Booti) and Trigonella foenum-graecum (Fenugreek Seeds) Supplemented Yogurt on Diabetes Management Among Adults Aged 30–40 Years

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1. Introduction:

Diabetes is a growing public health concern in Pakistan, affecting an estimated 90–95% of the population. Globally, over 537 million individuals are living with diabetes, and this number is increasing steadily. Management of diabetes through natural dietary interventions is gaining attention. *Withania coagulans* and *Trigonella foenum-graecum* (fenugreek) are traditional medicinal herbs known for their therapeutic properties, including the ability to regulate blood glucose levels by enhancing insulin secretion. This study aimed to develop and evaluate the efficacy of yogurt supplemented with these herbs in improving glycemic control among diabetic individuals.

2. Objectives:

The objectives of the study are to; evaluate the sensory, proximate, and phytochemical properties of yogurt supplemented with *Withania coagulans* and *Trigonella foenum-graecum; and* assess the bio-efficacy of supplemented yogurt in diabetic adults aged 30–40 years

3. Methodology:

A 40-day intervention involved 40 adult diabetic patients (aged 30–40 years). Yogurt was developed with varying levels of *Withania coagulans* and fenugreek seed powders: T0 (control), T1 (500 mg *W. coagulans*), T2 (600 mg *T. foenum-graecum*), and T3 (combined supplementation). Sensory evaluation employed a 9-point hedonic scale, while bio-efficacy was assessed through weight, height, BMI, waist-hip ratio, and random blood sugar levels before and after intervention. Statistical analysis determined significance at $p<0.05$ or $p<0.01$.

4. Results:

Yogurt sample T3 (combined supplementation) received the highest scores for taste, appearance, texture, and overall acceptability ($p>0.01$). Statistically significant improvements ($p<0.01$) were observed in the T3 group for: Weight reduction, BMI improvement, Waist-hip ratio (WHR), Reduction in random blood sugar (RBS) levels. Minimal changes were noted in T1, while the control group (T0) showed no significant improvement.

5. Conclusion & Recommendations:

The combined supplementation of *Withania coagulans* and *Trigonella foenum-graecum* in yogurt significantly improved multiple health parameters among diabetic individuals. These findings support the potential of functional foods as natural, non-pharmacological interventions for diabetes management. Further large-scale studies across diverse age groups and geographic regions are recommended to validate these outcomes and inform public health strategies.

Keywords: *Withania coagulans*, *Trigonella foenum-graecum*, functional yogurt, diabetes management, random blood sugar, herbal supplementation, glycemic control

Development of Biodegradable Packaging Film Using Pectin from Unripe Musa Peels and Starch from Mangifera indica Kernels

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1. Introduction:

The rising burden of non-biodegradable plastics necessitates sustainable alternatives. This study developed biodegradable packaging films using starch from *Mangifera indica* seed kernels and pectin from unripe *Musa* peels in a 3:1 ratio. Utilizing agro-wastes as raw materials offers a cost-effective, eco-friendly solution, aiming to reduce plastic pollution while fostering a circular bioeconomy through resource valorization.

2. Objectives:

The objectives of this study are to: extract and purify starch and pectin from mango seed kernels and unripe banana peels, respectively; develop a biodegradable film using these components and assess its mechanical, thermal, and physical properties; and evaluate the environmental biodegradability and potential use in food packaging.

3. Methodology:

Starch was extracted using distillation and purification techniques, while pectin was obtained via centrifugation of unripe banana peels. Glycerol was used as a plasticizer in the film formation process using the solvent casting method. The developed film was characterized for its mechanical strength, thickness, transparency, swelling capacity, moisture content, solubility, density, and biodegradability over 30 days.

4. Results:

The resulting biodegradable film demonstrated favorable physical and functional properties suitable for food packaging applications. It had a thickness of 0.177 ± 0.08 mm, water solubility of 26.47 ± 0.03%, and a moisture content of 23.52 ± 0.06%. The film's transparency was measured at 4.8 ± 0.01% at 760 nm, while its swelling capacity reached 41.59 ± 0.08%, indicating good water absorption potential. With a density of 1.21 ± 0.01 g/ml, the film maintained structural integrity. Biodegradability tests revealed complete degradation within 30 days, confirming its environmental sustainability. Additionally, the film exhibited strong tensile strength and adequate flexibility, essential qualities for handling and storage. These characteristics collectively suggest that the film is a promising candidate for eco-friendly food packaging solutions.

5. Conclusion & Recommendations:

This study demonstrates the viability of developing biodegradable films from underutilized agro-waste materials. The film's physical and mechanical properties, coupled with its biodegradability, position it as a strong candidate for replacing conventional plastic in food packaging. It is recommended that future research explores scalability, shelf-life testing with real food products, and commercial viability. Collaboration with packaging industries can also support the transition toward sustainable materials.

Keywords: Sustainability, Biodegradable Packaging, Starch-Pectin Film, Agro-Waste Utilization, Food Packaging Innovation

Eco-Safe Harvest: A Paradigm Shift in Post-Harvest Protection Using Natural Preservatives

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1. Introduction:

Post-harvest losses of fruits and vegetables contribute to global food insecurity, economic setbacks, and environmental harm. Rising consumer preference for health and sustainability drives interest in natural alternatives to synthetic preservatives. This study examines turmeric (*Curcuma longa*), clove (*Syzygium aromaticum*), cardamom (*Elettaria cardamomum*), and cinnamon (*Cinnamomum verum*) as eco-friendly preservatives, leveraging their antimicrobial, antifungal, and antioxidant properties to extend produce shelf life while maintaining safety and nutritional quality.

2. Objectives:

The objectives of the study are to: evaluate the effectiveness of spice-based natural preservatives in reducing microbial spoilage and oxidative deterioration of fruits and vegetables; assess the impact of treatments on physicochemical properties such as firmness, color, weight loss, and nutritional composition; compare the performance of natural preservatives with conventional synthetic preservatives; and analyze consumer acceptability through sensory evaluation.

3. Methodology:

Experimental trials on selected fruits and vegetables compared treated and untreated samples during controlled storage. Analyses included microbial load, enzymatic activity, moisture retention, firmness, color stability, and antioxidant capacity. Antimicrobial efficacy of extracts was tested against common spoilage microorganisms, while sensory evaluation assessed consumer preferences for aroma, texture, flavor, and visual appeal.

4. Results:

Natural preservatives significantly reduced microbial contamination and delayed spoilage, resulting in extended shelf life compared to untreated controls. Among the treatments, turmeric and clove exhibited the strongest antimicrobial effects, while cinnamon and cardamom contributed to improved antioxidant stability and sensory attributes. Comparative analysis with synthetic preservatives revealed that natural treatments provided comparable preservation outcomes without chemical residues or health risks.

5. Conclusion & Recommendations:

The study demonstrates that natural spice-based preservatives are viable, safe, and sustainable alternatives to synthetic preservatives for post-harvest protection. Their use could be especially beneficial for small-scale producers and organic supply chains. Further research is recommended to optimize formulations, ensure regulatory compliance, and explore scalability in commercial food systems. Integrating such green preservation strategies can play a crucial role in reducing food loss, promoting public health, and advancing climate-resilient food systems.

Keywords: Post-harvest Protection, Natural Preservatives, Turmeric, Clove, Cardamom

Socio-Economic Determinants of User Satisfaction with the Sehat Sahulat Program: Evidence from Vehari

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1. Introduction:

Access to quality healthcare is a fundamental human right and is enshrined in the third Sustainable Development Goal (SDG) of the United Nations, ensuring healthy lives and promoting well-being for all by 2030. In line with this, the Government of Pakistan launched the Sehat Sahulat Program (SSP) in collaboration with provincial governments to provide universal health coverage, particularly to underserved populations. The program was implemented in Vehari District, Southern Punjab, in 2019, aiming to benefit approximately 50 million people across the region. This study evaluates user satisfaction with inpatient healthcare services provided under SSP and investigates the socio-economic factors influencing satisfaction levels.

2. Objectives:

The objectives of this study are to: assess the level of user satisfaction with the Sehat Sahulat Program in Vehari; and identify the socio-economic determinants influencing satisfaction with healthcare services.

3. Methodology:

Primary data were collected from SSP beneficiaries using a structured questionnaire and a simple random sampling technique. A binary logistic regression model with marginal effects was applied to determine the influence of socio-economic variables on user satisfaction.

4. Results:

The results indicate that key socio-economic factors, such as family size, education level, income, self-reported health status, and use of social media, have a statistically significant and positive impact on satisfaction with SSP services. Larger households reported higher satisfaction levels, suggesting a perceived higher value from the program. Education and awareness, particularly through digital platforms, also correlated strongly with satisfaction outcomes.

5. Conclusion & Recommendations:

The study concludes that while the SSP has made progress in delivering healthcare services, its effectiveness can be further improved through digitalization, enhanced access to resources, and better service delivery. Recommendations include:

- Introducing health education and awareness campaigns to improve utilization.
- Expanding digital infrastructure for registration and feedback.
- Strengthening medical staff training and diagnostic facilities to enhance service quality.

Keywords: Sehat Sahulat Program, User Satisfaction, Healthcare Access, Socio-Economic Determinants, Vehari, Pakistan

How Pro-Environmental Attitude Forms Sustainable Purchasing Behavior in the Agri-Food Market? Exploring Climate Change Engagement and Moral Licensing

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1. Introduction:

In response to the growing threat of climate change, sustainable consumption practices have gained increasing importance, particularly in the agri-food sector. This study investigates how consumer engagement with climate change, encompassing cognitive, emotional, and behavioral dimensions, acts as a stimulus for forming pro-environmental attitudes, which in turn influence sustainable agri-food purchasing behavior. Additionally, the study examines the moderating effect of moral licensing, a psychological phenomenon that may reduce sustainable behaviors following an initial pro-environmental action. The theoretical underpinning draws from the Stimulus-Organism-Response (S-O-R) model and moral licensing theory.

2. Objectives:

The objectives of this are to: assess the effect of climate change engagement on pro-environmental attitudes; evaluate the impact of pro-environmental attitudes on sustainable agri-food purchasing behavior; and examine the moderating role of moral licensing in this relationship.

3. Methodology:

A purposive sampling technique was used to collect primary data from 500 respondents through a structured physical survey in two cities of Punjab, Pakistan. The study adopted a cross-sectional design under a post-positivist research paradigm. Data analysis was conducted using descriptive statistics, normality checks, and Partial Least Squares Structural Equation Modeling (PLS-SEM) via SPSS and SmartPLS 4.

4. Results:

The findings revealed a significant and positive association between all three dimensions of climate change engagement (cognitive, emotional, behavioral) and pro-environmental attitude. Furthermore, pro-environmental attitude significantly predicted sustainable agri-food purchasing behavior. The moderating role of moral licensing was found to be negative and statistically significant, indicating that it weakens the relationship between attitude and behavior.

5. Conclusion & Recommendations:

The study concludes that climate change engagement fosters pro-environmental attitudes, which positively influence sustainable agri-food consumption. However, moral licensing may act as a psychological barrier to sustained behavior. To address this, businesses should use communication strategies that discourage one-time “green” actions and promote continued sustainable behavior. The means-end chain model in integrated marketing communication may be particularly effective in aligning cognitive, emotional, and behavioral motivations. Policymakers should also consider subsidies to make sustainable agri-food products more accessible and enforce regulatory oversight to prevent false sustainability claims in the market.

Keywords: Climate Change, Sustainability, Agri-Food, Purchasing Behavior, Moral Licensing

Optimization of Probiotic Bioavailability in Ginger-Based Fermented Soda via Ginger Bug Enhancement

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1. Introduction:

The rising demand for functional non-dairy probiotic beverages is driven by increasing health consciousness and dietary restrictions. Ginger (*Zingiber officinale*), known for its antimicrobial, antioxidant, and anti-inflammatory properties, presents a promising substrate for fermentation. This study aimed to develop a probiotic-rich fermented ginger soda using a ginger bug starter culture enhanced with *Lactobacillus plantarum* and *Lactobacillus bulgaricus*. The primary objective was to assess probiotic viability, antioxidant potential, and sensory acceptability of the beverage as a functional alternative to conventional carbonated soft drinks.

2. Methodology:

The ginger bug was prepared by fermenting grated ginger with sucrose for 5–6 days under ambient conditions. The final beverage formulation included the ginger bug inoculum, honey, and lemon juice, fermented for 24 hours. Physicochemical analysis (pH, °Brix, titratable acidity), proximate composition (moisture, ash, crude fiber, fat), microbial enumeration, and antioxidant assays (DPPH scavenging activity, total phenolic content [TPC], and total flavonoid content [TFC]) were conducted. Ethanol content was quantified to ensure compliance with non-alcoholic standards. Sensory evaluation was carried out by a semi-trained panel, and shelf-life was assessed over 7 days under ambient and refrigerated storage.

3. Results:

The beverage exhibited a pH of 3.75, °Brix of 2, and titratable acidity of 1.61%, indicating a suitable acidic environment for probiotic growth. Moisture content was high (95.7%), with ash and crude fiber at 0.34% and 0.3%, respectively, and no detectable fat. The viable probiotic count reached 6 log CFU/mL, meeting the efficacy threshold for functional beverages. Antioxidant properties included 61.34% DPPH radical scavenging activity, 35.09 mg GAE/g TPC, and 19.86 mg QE/g TFC. Ethanol levels remained below 0.5%, within acceptable limits for non-alcoholic classification. Sensory evaluation indicated high consumer acceptability (≥8/10), and refrigerated samples maintained superior quality in terms of flavor and microbial stability.

4. Conclusion and Recommendations:

The formulated probiotic ginger soda demonstrated excellent functional, nutritional, and sensory attributes, highlighting its potential as a health-focused alternative to commercial carbonated beverages. The synergy between probiotic strains and ginger fermentation enhanced bioactivity and ensured safety without synthetic additives. Future research should explore natural preservation techniques and assess scalability for commercial production.

Keywords: Probiotic Beverage, Ginger Bug, Antioxidant Activity, Fermentation, Functional Foods, Non-dairy Probiotics

Agri-Transforming: Pioneering Integrative Innovations to Revolutionize Sustainable and Productive Agriculture

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1. Introduction:

"Agri-Transforming" is a paradigm promoting sustainable, tech-driven agriculture that balances productivity with environmental care. It integrates digital tools, biotechnology, climate-smart practices, and circular economy principles to enhance resilience and food security. Precision farming with AI, sensors, and remote sensing ensures efficient input use, while crop diversification, renewable energy, and waste valorization strengthen sustainability. Emphasizing inclusivity, it supports smallholders through equitable access to innovation, fostering an agriculture system that is resilient, future-ready, and environmentally responsible.

2. Objectives:

The objectives of this study are to: explore integrative innovations in agriculture for enhancing sustainability and productivity; examine the role of digital tools, biotechnology, and climate-smart practices in agri-food transformation; and assess the socio-economic and environmental benefits of adopting the Agri-Transforming model.

3. Methodology:

This conceptual study is based on a multidisciplinary review of existing literature, global practices, and recent advancements in agricultural technology and sustainability models. The analysis is framed through a systems-based perspective, integrating insights from agronomy, environmental science, and rural development.

4. Results:

The review highlights that integrating smart technologies and eco-friendly practices can significantly improve agricultural efficiency, reduce greenhouse gas emissions, and foster economic inclusion for smallholder farmers. The model demonstrates high potential for adoption in both developed and developing countries when supported by enabling policies and infrastructure.

5. Conclusion & Recommendations:

Agri-Transforming represents a strategic framework for the future of agriculture, combining productivity with ecological responsibility. To realize its full potential, investment in digital infrastructure, farmer training, policy incentives, and research on localized applications is essential. A collaborative effort among stakeholders, farmers, researchers, policymakers, and industry, is necessary to maintain sustainable innovation across agri-food systems.

Keywords:

Agri-Transforming, Climate-smart Farming, Nature-based Solutions, Precision Agriculture, Digital Tools, Sustainability, Circular Economy

Determinants of Growers' Intentions to Adopt Blockchain Technology in Pulses Supply Chains

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1. Introduction:

Agriculture plays a critical role in ensuring food security and supporting economic growth in Pakistan. Among key crops, pulses face persistent supply chain inefficiencies due to unstable production, limited market access, and declining farmer participation. Blockchain technology offers transformative potential by enabling transparency, traceability, and direct stakeholder engagement in agri-food supply chains. This study investigates growers' awareness, perceptions, and the determinants of their intentions to adopt blockchain technology in the pulses supply chain in Pakistan.

2. Objectives:

The study aimed to assess the level of awareness and perception among pulses growers regarding blockchain technology; identify the factors influencing growers' intentions to adopt blockchain technology; and examine the moderating role of perceived cost on these relationships.

3. Methodology:

The study applied an extended Unified Theory of Acceptance and Use of Technology (UTAUT) model, incorporating perceived risk as an independent variable and perceived cost as a moderating factor. Data were gathered from 204 pulse growers in Bhakkar and Chakwal, Punjab, through a structured, pre-tested questionnaire. Using a hybrid purposive–convenience sampling strategy, analyses included descriptive statistics in SPSS and Partial Least Squares Structural Equation Modeling (PLS-SEM) in SmartPLS to evaluate relationships and test hypotheses.

4. Results:

The results revealed limited baseline awareness of blockchain technology among growers; however, their openness to adoption increased significantly after being informed. All core constructs of the UTAUT model, performance expectancy, effort expectancy, social influence, and facilitating conditions, were found to significantly influence adoption intentions. Effort expectancy emerged as the strongest predictor. Perceived risk had a significant negative effect on adoption intention, while perceived cost moderated certain relationships, particularly strengthening the influence of facilitating conditions and perceived risk.

5. Conclusion & Recommendations:

The study concludes that, despite limited initial awareness, growers show strong potential to adopt blockchain solutions when supported with information and guidance. Adoption can be accelerated through grower cooperatives and user-friendly mobile apps, complemented by financial incentives, transparent pricing, and simple interfaces to reduce risk and cost barriers. Future research should apply this framework in longitudinal and cross-regional contexts to assess adoption outcomes and supply chain performance.

Keywords: Blockchain Technology, Agricultural Supply Chains, Pulses Growers, Technology Adoption, UTAUT Model, Perceived Risk, Perceived Cost

Lavender Jam: A Nutraceutical Approach to Mental Wellness

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1. Introduction:

Lavender (*Lavandula* spp.), a member of the mint family (*Lamiaceae*), is a well-known aromatic herb traditionally used for its medicinal, therapeutic, and culinary properties. It contains essential oils rich in monoterpenes such as linalool, linalyl acetate, geraniol, and eucalyptol, known for their antimicrobial, antifungal, and calming effects. Aromatherapists commonly use lavender to alleviate headaches, anxiety, stress, and fatigue, while herbalists apply it to treat skin infections, wounds, and joint pain.

This study aims to develop a functional food product, lavender jam, by integrating the health benefits of lavender into a fruit-based preserve. Jams are a widely accepted method for fruit preservation, offering extended shelf life and nutritional value. The incorporation of lavender enhances the jam's potential as a nutraceutical, promoting mental wellness through regular dietary intake.

2. Objectives:

The objectives of the study are to formulate a functional jam using lavender and fruit pulp (apple and plum); evaluate the nutritional and sensory properties of the lavender-infused jam; and explore the potential health benefits, particularly its effects on stress and mental well-being.

3. Methodology:

Ripe apple and plum fruits were selected, washed, and pulped. Sugar, citric acid, and pectin were added in appropriate proportions. Dried lavender flowers were incorporated during the boiling phase. The mixture was continuously stirred until the endpoint was reached (drop test). The final product was filled hot into sterilized glass containers and cooled at room temperature. Basic physicochemical properties and sensory evaluation were conducted to assess acceptability.

4. Results:

The lavender jam demonstrated good texture, spreadability, and appealing aroma, attributed to lavender's volatile compounds. Sensory panel feedback indicated high acceptability in terms of taste, color, and aroma. Nutritionally, the jam retained key phytochemicals from both fruit and lavender, making it a promising product for promoting mental relaxation and potentially reducing stress and anxiety.

5. Conclusion & Recommendations:

Lavender jam represents an innovative fusion of traditional herbal therapy and modern food processing. It offers both nutritional value and therapeutic potential, especially for consumers seeking natural approaches to mental health management. Further studies are recommended to quantify specific bioactive compounds, assess long-term storage stability, and evaluate clinical impacts on mood disorders.

Keywords: Lavender Jam, Nutraceutical, Mental Health, Monoterpenes, Functional Food, Phytochemicals, Stress Relief

Use of N-Acetylcysteine to Mitigate Ochratoxin A Toxicity in Poultry: A Step Toward Safer Feed and Sustainable Production

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1. Introduction:

Ochratoxin A (OTA), a mycotoxin produced by *Aspergillus* and *Penicillium* species, is a common contaminant in poultry feed. It poses significant health hazards, including immunosuppression, hepatotoxicity, nephrotoxicity, and reduced growth performance in broiler chickens. These negative effects compromise poultry health and threaten food safety and production sustainability.

2. Objectives:

This study aimed to evaluate the protective efficacy of N-acetylcysteine (NAC), a well-known antioxidant and glutathione precursor, against OTA-induced clinicopathological and histopathological alterations in broiler chickens. The ultimate goal was to explore its viability as a feed additive for enhancing poultry health and supporting safer, more sustainable production systems.

3. Methodology:

A total of 125, day-old broiler chicks were randomly assigned to five groups (n=25 each): Group A (Control), Group B (OTA only, 400 µg/kg feed), Group C (NAC only, 100 mg/kg feed), Group D (OTA + NAC), Group E (OTA + commercial toxin binder). The trial lasted for five weeks. Clinical observations, feed intake, body weight gain, gross and microscopic lesions, and serum biochemical parameters (ALT, AST, urea, creatinine, total protein) were monitored and statistically analyzed.

4. Results:

OTA exposure significantly ($p \leq 0.05$) reduced feed intake and weight gain while increasing serum markers of hepatic and renal injury. Gross pathology revealed enlarged, pale livers and swollen kidneys, while histopathology confirmed hepatocellular necrosis and renal tubular degeneration.

NAC supplementation substantially mitigated these effects. Birds in the NAC-treated group demonstrated improved growth performance, restored serum biochemical values, and preserved tissue integrity. The protective effects of NAC were found to be comparable to those of the commercial toxin binder.

5. Conclusion & Recommendations:

N-acetylcysteine effectively countered the toxic effects of OTA in broilers, restoring physiological and histological parameters close to normal. Given its antioxidant properties and affordability, NAC represents a promising feed additive to enhance poultry health, improve feed safety, and promote sustainable poultry production. Adoption of NAC in feed formulations may offer a viable strategy for reducing the burden of mycotoxins, thereby contributing to food security and resilient agri-food systems.

Keywords: Ochratoxin A, N-acetylcysteine, Poultry Feed Safety, Hepatotoxicity, Nephrotoxicity, Food Security, Mycotoxin Mitigation

Development and Evaluation of Gluten-Free Brownies Using Tapioca Pearl Flour

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1. Introduction:

The increasing prevalence of gluten intolerance and celiac disease has led to a growing demand for gluten-free alternatives in the food market. Traditional brownies, typically made with wheat flour, are not suitable for gluten-sensitive individuals. Tapioca pearl flour, derived from cassava starch, is a naturally gluten-free ingredient known for its smooth texture and neutral flavor. While commonly used in beverages like bubble tea, its application in baked goods remains underexplored. This study was designed to develop gluten-free brownies using tapioca pearl flour and evaluate their physicochemical, nutritional, and sensory properties compared to conventional wheat-based brownies.

2. Objectives:

The objectives of this study are to: formulate gluten-free brownies using tapioca pearl flour as a wheat flour substitute; evaluate their physical attributes (moisture content, pH); screen for phytochemicals such as alkaloids and flavonoids; and assess the sensory acceptability of the tapioca-based brownies compared to a wheat-based control.

3. Methodology:

Tapioca pearls were ground into fine flour and used to replace wheat flour in the brownie formulation. The batter was prepared with cocoa powder, sugar, oil, eggs, milk, vanilla, baking powder, and a pinch of salt, then baked at 180°C for 20–25 minutes. A control batch using wheat flour was prepared under identical conditions. Both samples were analyzed for moisture content, pH, phytochemical presence, and subjected to sensory evaluation using a 9-point hedonic scale by a semi-trained panel.

4. Results:

The gluten-free tapioca brownies exhibited a moisture content of 15.2 ± 0.04%, contributing to a moist and slightly chewy texture. The pH value was 6.5 ± 0.02, indicating mild acidity that enhanced chocolate flavor perception. Phytochemical screening revealed the presence of alkaloids and flavonoids, suggesting antioxidant potential. Sensory evaluation yielded favorable scores: taste (7.8 ± 0.1), appearance (8.1 ± 0.2), and overall acceptability (7.9 ± 0.1). Texture received a slightly lower score (6.3 ± 0.3) due to increased density compared to the wheat-based variant.

5. Conclusion & Recommendations:

Tapioca pearl flour is a viable gluten-free substitute in brownie formulations, offering good sensory qualities and potential health benefits due to phytochemical content. Although the texture was denser than traditional brownies, it did not negatively affect overall consumer acceptance. Future studies should explore texture enhancement using hydrocolloids or by blending with other gluten-free flours. Further research is also recommended to evaluate self-life and assess market acceptance on a larger scale.

Keywords: Gluten-free Brownies, Tapioca Pearl Flour, Phytochemicals, Sensory Evaluation, Gluten Intolerance, Functional Foods

Formulation, Characterization, and Nutritional Assessment of Gluten-Free Noodles Derived from Red Kidney Beans: Exploring Health Benefits and Culinary Applications

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1. Introduction:

With the rising prevalence of gluten intolerance and increasing demand for health-oriented functional foods, the development of gluten-free products has become essential. This study focuses on the formulation and characterization of gluten-free noodles made primarily from red kidney beans, rice flour, and pulse flour. These ingredients were selected for their rich nutritional profiles and potential to replicate the texture and palatability of conventional wheat-based noodles.

2. Objectives:

The objectives of this study are to: develop gluten-free noodles using red kidney beans and complementary flours; assess the physicochemical, nutritional, and sensory properties of the formulated noodles; and evaluate the potential health benefits and culinary versatility of the product.

3. Methodology:

Noodles were developed using a standardized blend of red kidney bean flour, rice flour, and pulse flour. Physicochemical analysis showed a moisture content of 16.75%, ash content of 0.4%, firmness of 30 Newtons, and a pH of 7.87, indicating good hydration, mineral balance, chewiness, and neutrality. Nutritional profiling highlighted dietary fiber, essential amino acids, and plant-based protein, while sensory evaluation assessed appearance, texture, taste, and overall acceptability, confirming product quality and consumer appeal.

4. Results:

The developed noodles demonstrated: a firm yet flexible texture that retained integrity post-cooking; a neutral pH suitable for culinary versatility; enhanced nutritional properties due to the incorporation of red kidney beans, providing increased levels of fiber and protein, and supporting gut health and satiety; and high consumer acceptability in sensory testing, indicating commercial potential.

5. Conclusion & Recommendations:

Red kidney beans, when combined with rice and pulse flour, serve as a promising base for gluten-free noodles, offering a nutritionally superior alternative to conventional pasta products. The formulation achieved a balanced texture, appealing flavor, and enhanced health benefits. Future research should explore shelf-life stability, fortification with micronutrients, and scaling for commercial production. Broader sensory panels could further validate market viability.

Keywords: Gluten-free Noodles, Red Kidney Beans, Rice Flour, Pulse Flour, Ash Content, Food Innovation.

Cassachos Bliss: A Gluten-Free, Cassava-Based Snack for Health-Conscious Consumers

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1. Introduction:

Cassachos Bliss is an innovative, baked snack designed as a gluten-free and grain-free alternative to traditional nachos. Made from cassava flour (derived from yuca root), this product is rich in resistant starch, offering functional health benefits such as improved digestive health, blood sugar regulation, weight management, and inflammation reduction. Drawing inspiration from the flavors of Mexican nachos, *Cassachos Bliss* caters to the growing demand for plant-based, allergen-free, and nutrient-dense snacks. This product addresses a significant gap in the snack food market by providing a suitable option for individuals with gluten intolerance, celiac disease, and other dietary restrictions. It also appeals to health-conscious consumers seeking clean-label products without compromising taste or convenience.

2. Objectives:

The objectives of this study are to: formulate a gluten-free, vegan, and grain-free snack using cassava flour; assess its nutritional properties and health benefits; evaluate sensory characteristics such as texture, taste, and appearance; and offer a shelf-stable, ready-to-eat product suitable for modern dietary needs.

3. Methodology:

The dough was prepared by mixing cassava flour with water, salt, and selected spices. It was shaped into chips and baked at 120°C for 15 minutes following a preheating stage at 180°C. The product was evaluated for texture, flavor, visual appeal, and nutritional value, focusing on its resistant starch content and low-fat profile. Sensory testing and preliminary shelf-life evaluation were also conducted.

4. Results:

The final product demonstrated favorable sensory attributes, including a smooth texture, savory flavor, and visually appealing appearance. Nutritional analysis highlighted its high resistant starch content and significantly lower fat levels compared to conventional fried snacks. The snack was shelf-stable and ready to eat, making it convenient for consumers seeking functional mini-meals or appetizers.

5. Conclusion & Recommendations:

Cassachos Bliss offers a compelling, health-oriented solution within the snack food industry. Its cassava-based formulation provides a safe and nutritious alternative to wheat-based products, particularly for individuals with celiac disease or gluten sensitivity. With its positive nutritional profile, ease of preparation, and consumer-friendly taste and texture, *Cassachos Bliss* aligns with global trends favoring clean-label, functional foods. Future studies may focus on fortification, packaging innovation, and extended shelf-life analysis to optimize market readiness and consumer appeal.

Keywords: Cassachos Bliss, Cassava Flour, Gluten-Free, Vegan, Ready-to-Eat

Seed Buying and Application Practices of Vegetable Growers in Punjab, Pakistan

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1. Introduction:

The vegetable subsector in Pakistan has immense potential to enhance food security, rural livelihoods, and overall socio-economic development. Yet, its progress is constrained by persistently low productivity, primarily due to poor seed quality and ineffective application practices. This study explores the seed procurement and usage behaviors of vegetable growers in Punjab, examining the socio-economic, informational, and institutional factors that shape their seed-related decisions and directly influence farm-level productivity and sustainability.

2. Objectives:

The objectives of this study are to: identify common seed-buying sources among vegetable growers; assess seed application and management practices; and explore factors affecting the adoption of improved seed practices.

3. Methodology:

A quantitative research design was employed, using primary data collected from 215 vegetable farmers in District Faisalabad, one of Punjab's leading vegetable-producing areas. Data were gathered via face-to-face interviews using a structured, pre-tested questionnaire. Descriptive statistical tools such as frequency distributions and cross-tabulations were applied to analyze the data.

4. Results:

Most farmers reported purchasing seeds from local markets and neighboring growers, primarily due to cost-effectiveness and accessibility. However, reliance on uncertified and low-quality seeds was widespread. Seed application practices varied significantly, reflecting disparities in farmers' awareness, education, and resource availability. Less than half of the respondents used modern sowing equipment or applied treatments like fungicides, seed cleaning, or germination enhancers. These gaps highlight limited exposure to good agricultural practices and a reliance on traditional, low-efficiency methods.

5. Conclusion & Recommendations:

The study underscores the urgent need to improve farmers' access to certified seeds and enhance their awareness of seed treatment and modern sowing techniques. Strengthening extension services, promoting public-private partnerships for certified seed distribution, and implementing targeted training programs can play a vital role in upgrading seed management practices. Such interventions are essential for improving productivity, reducing input waste, and fostering the long-term development of Pakistan's vegetable industry.

Keywords: Vegetables, Seed Management, Seed Sourcing, Agricultural Productivity, Punjab, Pakistan

3-Nitrooxypropanol (3-NOP) as a Methane-Reducing Feed Additive: Impacts on Enteric Emissions and Milk Quality in Dairy Cattle

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1. Introduction:

Enteric methane from ruminants is a major contributor to global greenhouse gas emissions, challenging sustainable livestock systems. 3-nitrooxypropanol (3-NOP) has emerged as an effective feed additive, inhibiting the enzyme methyl-coenzyme M reductase in methanogenic archaea to reduce methane without harming productivity. Trials report up to 30% emission reductions, with energy-corrected milk yield, milk protein, dry matter intake, and rumen fermentation maintained, confirming 3-NOP's potential as a climate-smart livestock mitigation strategy.

2. Objectives:

The objectives of this study are to: evaluate the effectiveness of 3-NOP in reducing enteric methane emissions in dairy cattle; assess the impact of 3-NOP on milk yield, quality, and composition; and explore the practical considerations of 3-NOP use in climate-smart livestock systems in developing countries.

3. Methodology:

This review synthesizes peer-reviewed studies and meta-analyses on 3-NOP use in dairy systems, drawing on trials with Holstein and crossbred cattle in temperate and tropical climates. It evaluates methane reduction, milk yield and composition, dry matter intake, and rumen fermentation, while also considering diet, lactation stage, breed variation, and environmental factors such as heat stress.

4. Results:

Evidence suggests that 3-NOP can reduce methane emissions by 20–30% without compromising milk production. In some cases, modest improvements in energy-corrected milk and milk protein content were observed. The additive exhibited consistent performance across various dietary formulations, although its efficacy was influenced by forage-to-concentrate ratio and production stage. No detrimental effects on feed intake or rumen function were reported. The synergistic potential of combining 3-NOP with other mitigation strategies (e.g., nitrates, tannins, and precision feeding) presents a promising avenue for future research.

5. Conclusion & Recommendations:

3-NOP offers a validated, practical solution for mitigating enteric methane in dairy systems. Its adoption in developing countries like Pakistan, where high-yield crossbreeds are expanding, could advance climate-smart livestock goals. Wider uptake requires farmer training, supportive regulations, and financial incentives, while future research should assess long-term impacts, cost-effectiveness, and environmental co-benefits.

Keywords: 3-Nitrooxypropanol (3-NOP); Enteric Methane; Feed Additives; Dairy Cattle; Milk Quality; GHG Mitigation; Sustainable Livestock; Rumen Fermentation; Holstein Crossbreeds; Climate-smart Agriculture

Innovative Substitution of Sucrose with Stevia and Chicory Root in Eclairs: Implications for Food Security and Market Dynamics

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1. Introduction:

The rising burden of non-communicable diseases and increasing demand for healthier foods are driving innovation in the confectionery sector. This study reformulates traditional éclairs by substituting sucrose with stevia glycosides and incorporating chicory root (*Cichorium intybus*) powder as a prebiotic fiber source. Stevia lowers glycemic load, while chicory root enhances dietary fiber and supports gut microbiota modulation. This dual substitution addresses sugar-related health concerns and advances functional food development, offering nutrient-enriched, consumer-friendly products aligned with food security and market transformation goals.

2. Objectives:

The objectives of this study are to: evaluate the feasibility of replacing sucrose with stevia in éclair formulations; assess the nutritional and functional benefits of chicory root incorporation; examine the sensory acceptability and physicochemical properties of the reformulated product; and explore implications for market adoption and food system sustainability.

3. Methodology:

A standard éclair recipe was reformulated by replacing sucrose with varying concentrations of stevia glycosides and enriching the filling with chicory root powder. The product was evaluated through physicochemical analysis of moisture, texture, and color; nutritional profiling for caloric reduction, fiber, and glycemic index; sensory assessment using a 9-point hedonic scale; and preliminary market feasibility surveys.

4. Results:

The substitution significantly reduced overall sugar content without adversely affecting texture or flavor when optimal stevia concentrations were used. Chicory root addition improved fiber content and offered mild prebiotic benefits. Sensory scores indicated high consumer acceptability for formulations with balanced sweetness and texture. Panelists positively rated the éclairs for taste, appearance, and overall acceptability. The reformulated éclairs demonstrated potential for inclusion in functional and diabetic-friendly food categories.

5. Conclusion & Recommendations:

The use of stevia and chicory root in confectionery applications like éclairs is a promising innovation that addresses public health concerns, promotes dietary diversification, and meets consumer demand for low-sugar, fiber-enriched products. Future research should explore shelf-life stability, bioavailability of inulin post-processing, and large-scale consumer perception. Scaling such innovations could contribute to more resilient agri-food systems and expand the functional food market in developing economies.

Keywords: Stevia Glycosides, Chicory Root, Functional Confectionery, Inulin-type Fructans, Microbiota Modulation, Sugar-free Eclairs, Food System Innovation, Dietary Fiber Enrichment

Synergistic Immunosuppression by Ochratoxin A and Fowl Adenovirus-4 in Broilers: Implications for Poultry Health and Food Security

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1. Introduction:

Immunosuppressive factors pose a significant threat to poultry health and global food security. Among these, Ochratoxin A (OTA), a common mycotoxin, and Fowl Adenovirus serotype 4 (FAdV-4), the etiological agent of hydropericardium syndrome and inclusion body hepatitis, are of particular concern. While each is known for its deleterious impact on the avian immune system, limited data exist on their combined effects, particularly under intensive poultry farming conditions.

2. Objective:

To investigate the synergistic immunosuppressive and pathological effects of co-exposure to OTA and FAdV-4 in broiler chickens.

3. Methodology:

A total of 144, day-old broiler chicks were randomly allocated into six groups and exposed to OTA (200 or 400 ppb), FAdV-4, or their combinations for 35 days. FAdV-4 infection was confirmed by PCR and administered subcutaneously. Clinical signs, mortality, feed intake, and body weight were recorded. Immune responses were assessed through SRBC antibody titers, PHA-P–induced lymphoproliferative response, and carbon clearance assay, alongside gross and histopathological evaluation of lymphoid organs.

4. Results:

OTA exposure caused a dose-dependent suppression of immune function, evident from reduced antibody titers, lymphocyte proliferation, and phagocytic activity. FAdV-4 infection alone produced moderate immunosuppression, but co-exposure with OTA markedly intensified immune dysfunction. Outcomes included severe lymphoid atrophy, extensive histopathological lesions, and increased mortality. The combined treatment produced a compounded immunopathological response, far greater than the individual effects of either OTA or FAdV-4.

5. Conclusion & Recommendations:

This study provides compelling evidence of a synergistic immunosuppressive interaction between OTA and FAdV-4 in broiler chickens. These findings underscore the urgent need for integrated control strategies involving effective mycotoxin mitigation and robust viral surveillance. Strengthening poultry biosecurity and feed safety protocols is critical to preserving animal health and ensuring the sustainability of poultry-based food systems.

Keywords: Ochratoxin A, Fowl Adenovirus-4, Inclusion Body Hepatitis, Broiler Chickens, Immunosuppression, Mycotoxicosis, Poultry Health, Food Security

Probiotic-Enriched Fermented Kefir Formulation: A Symbiotic Functional Beverage for Gut Health and Nutritional Wellness

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1. Introduction:

Rising consumer demand for functional beverages has accelerated the development of probiotic-enriched products, particularly for individuals with lactose intolerance or dietary restrictions. Kefir, a fermented milk drink rich in probiotics, vitamins, and minerals, is valued for its gut health benefits. Yet, limited studies explore fruit-based innovations. This research developed and evaluated a mango-infused kefir formulation designed to enhance palatability, lower lactose content, and improve both sensory attributes and nutritional quality.

2. Objectives:

The objectives of this research are to: formulate a lactose-reduced, fruit-based kefir beverage using mango pulp; evaluate its physicochemical properties (pH, viscosity, total soluble solids); assess the viability of probiotic strains during refrigerated storage; and compare sensory attributes (taste, color, texture, overall acceptability) under different storage conditions.

3. Methodology:

Kefir was prepared by fermenting 100 mL of cow's milk with 22 g of fresh kefir grains at ~30°C for 24 hours. Post-fermentation, kefir grains were removed using sterile cheesecloth. Two formulations were developed by blending fermented kefir with 80 g of ripe mango pulp and 80 g of strawberry pulp, respectively. Each was supplemented with 22 g of granulated sugar and 5 mL of flavored syrup. Samples were stored at 4°C and room temperature for comparative analysis of physicochemical and sensory properties over time.

4. Results:

The mango-kefir formulation initially exhibited a pH of 4.3 ± 0.02, which remained stable (4.2 ± 0.01) under refrigeration but declined to 3.8 ± 0.01 at room temperature by Day 3, increasing sourness and reducing appeal. Sensory evaluation showed significantly higher scores for refrigerated samples in taste (8.0 ± 0.2) and overall acceptability (8.2 ± 0.1) versus room-temperature storage (taste: 6.4 ± 0.3). Statistically significant differences ($p < 0.05$) were observed in sensory and physicochemical attributes between storage conditions.

5. Conclusion & Recommendations:

This study demonstrates the potential of mango-based kefir as a nutritious, lactose-reduced, probiotic-rich functional beverage. Proper refrigeration is essential to maintain quality and consumer appeal. While the formulation was well-received, limitations include a short evaluation period and a small sample size. Future research should explore long-term microbial stability, bioavailability of probiotics, and consumer preferences across diverse populations to support commercialization.

Keywords: Probiotic Beverage, Kefir, Mango Formulation, Functional Food, Fermentation, Lactose-reduced, Gut Health, Sensory Evaluation, Consumer Acceptability, Physicochemical Properties.

Phenotyping of Wheat Genotypes for Water Stress Tolerance in Yield-Related Traits

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1. Introduction:

Wheat (*Triticum aestivum L.*) is the staple food crop of Pakistan, providing nearly 20% of the population's protein and dietary fiber intake. However, climate change has led to irregular precipitation, increased drought frequency, and heatwaves, with nearly 50% of wheat-growing areas now prone to water stress. This study was conducted to evaluate the drought tolerance of wheat genotypes under water-limited conditions, focusing on yield-related traits, with the goal of developing resilient breeding material.

2. Objectives:

The objectives of this study are to: assess the impact of water stress on agronomic and physiological traits in wheat; identify promising parental genotypes and crosses based on combining ability for drought tolerance; and support future breeding programs targeting water stress resilience.

3. Methodology:

The study was conducted at the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad, using 29 genotypes (9 parental lines and 20 crosses) arranged in a Randomized Complete Block Design with two replications. Drought stress was imposed by providing only the first irrigation 20 days after snowing, with subsequent growth under rainfed conditions. Traits recorded included plant height, flag leaf area, tillers per plant, spike length, grains per spike, 1000-grain weight, and physiological indicators. Data were analyzed through ANOVA, and Line × Tester analysis estimated GCA and SCA effects.

4. Results:

ANOVA revealed highly significant variation among genotypes for all studied traits. Bhakkar Star and Longreach Impala showed desirable negative GCA effects for plant height, a key trait under drought stress, while Punjab-2011 and Longreach Beaufort emerged as strong general combiners for yield per plant. Favorable SCA effects for plant height were observed in crosses such as Bhakkar Star × Longreach Beaufort, Bhakkar Star × Longreach Gauntlet, and 10171 × Longreach Impala. Promising combinations for yield traits included Punjab-2011 × Longreach Gauntlet, Nawab-2021 × Livingston, Ghazi-2019 × Longreach Gauntlet, and Nawab-2021 × Longreach Impala.

5. Conclusion & Recommendations:

The study identified both parental lines and specific crosses with strong performance under water stress, offering valuable genetic resources for drought-tolerant wheat breeding programs. These genotypes can be exploited further to develop high-yielding, climate-resilient wheat cultivars suitable for Pakistan's increasingly arid production environments. Future efforts should also include molecular characterization and multi-location trials to validate these findings.

Keywords: Wheat, Water Stress, Drought Tolerance, Climate Change, Yield Traits, Breeding, Combining Ability

Towards a Zero-Waste Future: Development of Eco-Friendly Edible Crockery to Reduce Plastic Waste

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1. Introduction:

The environmental and health risks linked to plastic waste have intensified the search for sustainable alternatives, with edible crockery emerging as a promising eco-friendly innovation. Unlike plastic cutlery, which pollutes ecosystems and releases toxic substances when heated, edible utensils are biodegradable, non-toxic, and safe. Designed for strength and functionality, they are fully consumable or compostable after use, supporting zero-waste lifestyles and healthier choices. With ongoing research and innovation, edible tableware could revolutionize food service, hospitality, and packaging sectors, reducing plastic dependence and advancing global sustainability goals.

2. Objectives:

The objectives of this study are to: develop edible crockery as a sustainable alternative to plastic cutlery; evaluate its functional, sensory, and environmental performance; and assess its potential for commercial use in the food industry.

3. Methodology:

Raw materials such as wheat flour, rice flour, and edible gums were used to formulate edible crockery prototypes. The production process included dough preparation, shaping, baking, and drying under controlled conditions. Physical properties such as strength, heat resistance, and durability were assessed. Sensory evaluation was conducted for taste, texture, and appearance. Degradation and biodegradability were tested under natural conditions to validate environmental performance.

4. Results:

The developed edible crockery demonstrated sufficient strength and resistance to hot and cold foods. Sensory tests showed high consumer acceptance, particularly in terms of texture and mild flavor. Biodegradation trials confirmed the complete breakdown of material within a short time under composting conditions. The prototypes proved to be cost-effective and scalable, indicating strong commercial potential for use in restaurants, catering, and takeout services.

5. Conclusion & Recommendations:

Edible crockery represents a practical, health-conscious, and sustainable alternative to traditional plastic utensils. The study confirms its functionality, consumer appeal, and environmental advantages. Scaling up its use could significantly reduce plastic waste and support environmental conservation efforts. It is recommended that awareness campaigns and government incentives be introduced to promote widespread adoption in the food industry.

Keywords: Edible Crockery, Sustainable Packaging, Plastic Waste Reduction, Food Innovation, Biodegradable Tableware

Navigating the Link Between Food Security and Market Dynamics

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1. Introduction:

Ensuring food security is a pressing global challenge, especially in developing nations, where reliable access to safe, sufficient, and nutritious food is threatened by unstable market dynamics. Price volatility, inefficient distribution, and limited market access restrict availability and affordability, often leaving low-income households vulnerable. External shocks like climate change, inflation, conflicts, and pandemics further destabilize supply chains, intensifying risks. Addressing these issues requires harmonizing agricultural, trade, and economic policies, strengthening market institutions, ensuring fair pricing, and empowering smallholders with timely information and risk management tools to build resilient food systems.

2. Objectives:

The objectives of this study are to: explore the relationship between food security and market dynamics in developing countries; identify how price volatility and market inefficiencies affect food access and availability; and propose actionable strategies for improving market resilience and ensuring long-term food security.

3. Methodology:

This study is based on a qualitative synthesis of secondary data, including academic literature, global reports (FAO, WFP, IFPRI), and market trend analyses from 2015–2024. A case-based approach was used to examine selected developing countries facing food insecurity due to market instability. Policy interventions were also reviewed to assess their effectiveness in mitigating market-induced food insecurity.

4. Results:

Findings indicate a strong correlation between market disruptions and reduced food accessibility. Regions with weak supply chains and inadequate policy responses experienced the highest levels of food insecurity during global shocks (e.g., COVID-19, Ukraine-Russia war). Conversely, countries with robust market linkages and proactive agricultural reforms maintained relatively stable food systems. Key factors affecting food security include limited market access for smallholders, poor infrastructure, lack of pricing transparency, and inadequate storage and transportation systems.

5. Conclusion & Recommendations:

Effective management of market dynamics is essential to achieving food security. Governments should focus on building resilient supply chains, ensuring fair pricing mechanisms, and strengthening farmer-market linkages. Investing in digital platforms for real-time price monitoring, improving rural infrastructure, and encouraging public-private partnerships in agriculture are critical for long-term stability. A market-driven approach—when aligned with social protection and climate adaptation policies can significantly enhance food security outcomes.

Keywords: Food Security, Market Dynamics, Supply Chain Stability, Price Volatility, Agricultural Policy, Developing Countries

Creating a Health-Boosting Probiotic Chocolate Spread Using an Innovative Approach

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1. Introduction:

The increasing demand for functional foods has led to innovative formulations that enhance both nutrition and consumer appeal. This study explores the development of a probiotic-enriched chocolate spread by incorporating hazelnuts, known for their healthy fats and micronutrients, and yogurt powder, a source of beneficial probiotic bacteria. The resulting product aims to improve gut health while maintaining sensory appeal, contributing to sustainable food innovation and value addition in the confectionery industry.

2. Objectives:

The objectives of this research are to: formulate a functional chocolate spread fortified with *Lactobacillus plantarum;* evaluate its nutritional, microbiological, physicochemical, and sensory properties; and assess its potential health benefits and market acceptability.

3. Methodology:

The spread was formulated using hazelnuts, yogurt powder, cocoa, sugar, and probiotic cultures. Physicochemical parameters, including moisture, ash, fat, protein content, and viscosity, were measured using standard analytical methods. Microbial analysis was conducted to quantify probiotic viability (CFU/g). Sensory evaluation was performed using a 9-point hedonic scale to assess taste, texture, aroma, and overall acceptability.

4. Results:

The product showed: Moisture content of 12.87% ± 0.02; Ash content of 0.73% ± 0.15; Fat content of 34.53% ± 0.25, slightly lower than conventional chocolate spreads; Protein content of 7.42% ± 0.11 due to the inclusion of milk solids and hazelnuts; Viscosity of 350.63 ± 0.25, indicating smooth spread ability; and Probiotic count of 111.00 ± 3.61 CFU/g, confirming a viable probiotic population. The nutritional composition indicated a balanced and health-focused formulation. Sensory evaluation results showed high acceptability, particularly in terms of taste and texture, with the hazelnut and yogurt combination enhancing flavor and creaminess. The formulation successfully retained probiotic viability during refrigerated storage.

5. Conclusion & Recommendations:

The study demonstrates that a chocolate spread fortified with *Lactobacillus plantarum*, hazelnuts, and yogurt powder can serve as a functional food with potential gut health benefits. It combines nutritional enhancement with consumer-friendly characteristics, making it a promising alternative to traditional spreads. Future research should explore long-term probiotic stability, shelf-life optimization, and consumer preference across different age groups.

Keywords: Probiotic Chocolate Spread, *Lactobacillus Plantarum*, Hazelnuts, Yogurt Powder, Functional Foods, Gut Health, Sensory Evaluation

Preparation of Fish Pickle for Improving Community Nutritional Status

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1. Introduction:

This study focuses on the formulation of a nutrient-dense fish pickle using *Croaker fish* (*Mushka*) as a cost-effective and accessible protein source. The initiative aims to improve community nutritional status, particularly in low-resource settings, through a functional, shelf-stable food product. The pickle was prepared using traditional preservation techniques, including marination with natural spices and mustard oil, followed by storage in sterilized glass jars to monitor shelf life and product safety.

2. Objectives:

The objectives of this research are to: develop a nutritious and shelf-stable fish pickle using locally available fish; evaluate its nutritional composition, physicochemical stability, and sensory acceptability; and assess its potential as a community-level intervention for improving dietary diversity and reducing malnutrition.

3. Methodology:

The fish pickle was prepared by thoroughly cleaning and marinating *Croaker fish* in a mixture of spices and mustard oil. The product was stored in airtight glass jars at ambient temperature for 15 days. Physicochemical analysis included pH, moisture, protein, ash, and lipid content. Oxidative stability was monitored, and sensory evaluation was conducted using a trained panel to assess taste, texture, aroma, and overall acceptability.

4. Results:

The physicochemical analysis revealed: pH level 3.52, indicating a favorable acidic environment for microbial inhibition; Protein content 18.9%; Ash content 6.6%; Moisture content 6.0%; and Lipid content 2.82%. These results confirm the product's richness in macronutrients and essential minerals. Sensory evaluation showed high acceptability in terms of flavor, texture, and appearance. The product remained stable and safe under ambient storage for 15 days, with oxidative indicators remaining within acceptable limits.

5. Conclusion & Recommendations:

The developed fish pickle is a nutritionally valuable, shelf-stable product with strong potential as a community-level intervention for addressing protein-energy malnutrition. Its formulation aligns with sustainable and traditional food preservation practices. Further research on extended shelf-life stability, microbial safety, and packaging innovations is recommended to scale the product for commercial or public health nutrition programs.

Keywords: Croaker Fish, Functional Food, Protein-rich Pickle, Nutritional Security, Mustard Oil, Traditional Preservation, Community Health

Development of Sustainable Pulse Flour Nuggets with Cucumber Peel: A Novel Functional Food Product

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1. Introduction:

The global food processing industry generates large volumes of fruit and vegetable waste, much of which remains underutilized despite being rich in dietary fiber and bioactive compounds. Cucumber peels, typically discarded during processing, offer potential as a functional food ingredient. This study aims to valorize cucumber peel by incorporating its powdered form into pulse flour-based nuggets, promoting waste reduction and nutritional enhancement. This approach aligns with global priorities on sustainable food systems, health-conscious eating, and circular economy practices.

2. Objectives:

The objectives of this study are to: develop high-protein, fiber-rich plant-based nuggets using pulse flour and cucumber peel powder; assess the nutritional, functional, and sensory attributes of the developed product; evaluate the shelf stability and consumer acceptability of the formulation; and support food waste valorization through innovative product design.

3. Methodology:

Cucumber peels were cleaned, dehydrated, and ground into fine powder. A base was prepared using pulses flour (e.g., chickpea and lentil), with varying concentrations of cucumber peel powder (5%, 10%, 15%) incorporated into nugget formulations. Proximate composition (moisture, protein, fat, ash, fiber), antioxidant activity (DPPH assay), and polyphenol content were analyzed. Texture profile analysis and sensory evaluation were conducted using a semi-trained panel. Shelf-life analysis was performed under refrigerated storage over a 10-day period.

4. Results:

The inclusion of cucumber peel powder significantly increased dietary fiber content (up to 8.2%) and total polyphenol content without adversely affecting the taste, aroma, or texture of the nuggets. The 10% peel formulation demonstrated optimal balance between nutrition and sensory appeal. Antioxidant activity increased by 18–25% depending on the formulation. Textural firmness and chewiness improved with peel addition, enhancing product integrity. Sensory evaluation showed overall acceptability scores above 7.5 (on a 9-point scale). The product remained microbiologically safe and organoleptically stable during the tested storage period.

5. Conclusion & Recommendations:

The study demonstrates the feasibility of developing sustainable, plant-based nuggets enriched with cucumber peel powder, combining nutritional enhancement with waste reduction. The formulation meets consumer preferences for clean-label, functional foods while supporting environmental goals. Further research may explore commercial scale-up, expanded shelf-life testing, and exploration of other vegetable by-products for similar functional applications.

Keywords: Cucumber Peel, Waste Valorization, Plant-based Nuggets, Functional Foods, Dietary Fiber, Pulse Flour, Antioxidant Activity, Circular Economy

Lotus Seed-Infused Instant Kheer Mix: A Functional Dessert for Nutritional Enhancement

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1. Introduction:

Rising consumer demand for functional foods has fueled interest in plant-based nutraceuticals. *Euryale ferox* (lotus seeds or makhana), an underutilized aquatic crop, is abundant in flavonoids, alkaloids, phenolics, and essential minerals. Despite its antioxidant, anti-tumor, and neuroprotective potential, its use in mainstream foods remains limited. Traditional South Asian desserts like kheer are convenient yet nutrient-poor, being low in fiber and protein but high in sugars and starch, creating opportunities for reformulation that merges tradition with modern nutrition.

2. Objectives:

This study aimed to develop and evaluate a lotus seed-based instant kheer mix with enhanced nutritional and functional properties. The specific objectives were to: analyze the nutritional and phytochemical composition of lotus seeds; formulate an instant kheer mix using lotus seed powder and complementary ingredients; assess the product's physicochemical, functional, and sensory properties; and evaluate shelf stability and commercial potential.

3. Methodology:

Lotus seeds were roasted, ground into fine powder, and combined with powdered sugar, crushed almonds, pistachios, and flavoring agents (cardamom and vanilla). Nutritional analysis measured moisture, ash, dietary fiber, protein, and carbohydrates, while °Brix and colorimetric tests evaluated physicochemical traits. Phytochemical assays determined DPPH radical scavenging activity, total phenolic content (TPC), and total flavonoid content (TFC). Sensory evaluation employed a 10-point hedonic scale, and shelf life was assessed through moisture content and ambient stability.

4. Results:

The developed kheer mix showed a favorable nutritional profile: carbohydrates (62.8%), protein (13.2%), dietary fiber (9.5%), fat (3.1%), and low moisture (4.2%), indicating good shelf life. The product demonstrated moderate antioxidant activity with DPPH radical scavenging capacity of 55.66%, supported by significant TPC and TFC levels. Sensory evaluation yielded high consumer acceptability, with an average score of 8.6/10 across texture, taste, aroma, and appearance. The inclusion of nuts and natural flavorings enhanced palatability without compromising nutritional integrity.

5. Conclusion & Recommendations:

This study highlights the potential of incorporating *Euryale ferox* into instant desserts to create nutrient-rich, shelf-stable functional foods. The lotus seed-based kheer mix blends traditional flavors with modern health benefits, supporting commercial viability. Findings encourage wider use of lotus seeds in functional foods, with future research on efficacy, optimization, and scale-up.

Keywords: Lotus Seeds, Instant Kheer Mix, Functional Food, Antioxidant Activity, Nutraceuticals, Shelf-stable Dessert, Bioactive Compounds

Development of Gluten-Free Lentil Chips: A Functional Snack for Health-Conscious Consumers

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1. Introduction:

Lentil chips were developed as a gluten-free, plant-based alternative to fried snacks, designed for individuals with gluten intolerance and health-conscious consumers. Formulated from yellow lentil, oat, and corn flours, they provide protein, dietary fiber, and low saturated fat. Inspired by traditional savory snacks, the product meets growing demand for functional, clean-label, and sustainable foods. Suitable for children, athletes, and vegans, lentil chips deliver a satisfying, guilt-free snacking experience with enhanced nutritional value.

2. Objectives:

The objectives of this research are to: develop a gluten-free, plant-based baked snack using lentils and whole grains; evaluate the nutritional, sensory, and functional properties of the product; and explore its potential as a sustainable and health-promoting food item for gluten-sensitive and wellness-focused consumers.

3. Methodology:

Yellow lentils were milled and lightly toasted to enhance flavor and aroma. The lentil flour was blended with oat and corn flour, salt, and water to form dough, which was sheeted, shaped, and baked under controlled temperature and moisture conditions. Deep frying was avoided to reduce fat content. The final product underwent physicochemical analysis (moisture, protein, fat, fiber), and sensory evaluation (taste, texture, appearance) using a consumer panel. Environmental considerations were also incorporated through eco-friendly ingredient sourcing and biodegradable packaging.

4. Results:

The developed Lentil Chips demonstrated a high protein and fiber profile with low saturated fat content. Nutritional analysis showed that the chips provided a balanced macronutrient composition suitable for health-conscious and allergen-sensitive diets. Sensory evaluation revealed strong consumer acceptance for taste, texture, and crunchiness. The chips were appreciated for their natural flavor, clean ingredients, and baked preparation. Feedback supported their potential as a marketable functional snack. Sustainable formulation and packaging choices further reinforced the product's alignment with circular food economy goals.

5. Conclusion & Recommendations:

Lentil Chips offer a nutritionally dense, gluten-free alternative to conventional snacks, addressing modern dietary preferences and sustainability challenges. Their clean-label profile, health benefits, and strong consumer appeal position them as a promising entrant in the functional snack food market. Future research should focus on enhancing shelf stability, flavor variations, and large-scale production to optimize commercial viability.

Keywords: Gluten-free Snack; Lentil Chips; Plant-based Nutrition; Functional Food; Sustainable Food Innovation

Transforming the Livestock Sector to Meet Global Food Demands: Challenges and Strategic Directions

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1. Introduction:

The global livestock sector is undergoing rapid transformation driven by increasing demand for animal-based food products, particularly in developing and urbanizing regions. This shift is influenced by population growth, rising incomes, and changing dietary preferences. As production systems become more intensive and commercialized, challenges related to sustainability, environmental impact, and equity emerge. Small-scale producers face declining competitiveness, while intensified systems contribute to greenhouse gas emissions, land degradation, and water pollution. Addressing these issues is essential for meeting global food requirements in a socially and environmentally responsible manner.

2. Objectives:

This study aims to: analyze key trends driving transformation in the livestock sector globally and in Pakistan; identify challenges faced by smallholder producers amid intensification and market consolidation; and highlight policy and technological strategies to ensure sustainable, inclusive growth in livestock production.

3. Methodology:

A qualitative review of global and national literature was conducted, with secondary data sourced from FAO, ILRI, and national livestock statistics. Case studies from developing countries were compared to assess the impact of intensification and policy interventions. Focus was placed on identifying drivers of transformation and strategies aligned with the “One Health” and sustainability frameworks.

4. Results:

Findings indicate a pronounced shift toward vertically integrated, high-input livestock systems in response to market demand. However, these systems pose risks to environmental health and social equity. Small-scale producers often lack access to infrastructure, credit, and markets, exacerbating inequality. Countries that invested in sustainable intensification, disease surveillance, and market access such as Brazil and Vietnam demonstrate improved productivity and resilience. A “One Health” approach was found to be effective in addressing zoonotic risks and antimicrobial resistance.

5. Conclusion & Recommendations:

To meet rising global food demand, the livestock sector must undergo a transformation that is sustainable, equitable, and health conscious. Policymakers should: support small-scale farmers through targeted subsidies, training, and infrastructure; promote climate-smart and resource-efficient livestock practices; integrate One Health principles into livestock governance; and invest in research and innovation to improve productivity without compromising environmental integrity.

Keywords: Livestock Transformation, Sustainable Intensification, One Health, Food Security, Smallholder Farmers, Climate-smart Agriculture

Development of Functional Focaccia Soft Bread Enriched with Spinach Powder and Nutrient-Dense Ingredients

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1. Introduction:

In response to rising consumer demand for affordable, health-promoting foods, this study aimed to develop a functional soft focaccia bread enriched with spinach powder and other nutrient-dense ingredients. Spinach was selected for its high levels of iron, dietary fiber, vitamins A, C, and K, folate, and antioxidants. Its inclusion not only enhances nutritional value but also introduces a mild earthy flavor and natural green hue. The formulation also incorporated additional wholesome components to improve the bread's digestive support, antioxidant capacity, and dietary value, without compromising its soft texture or sensory appeal.

2. Objectives:

The objectives of this study are to: develop a nutritionally enhanced focaccia bread using spinach powder and other healthy ingredients; evaluate the physicochemical properties and sensory acceptability of the developed product; and assess the bread's potential as a functional food product for health-conscious consumers.

3. Methodology:

The bread was prepared using standard focaccia dough infused with spinach powder and selected whole-grain flours. Proximate analysis was conducted to determine moisture, ash, fat content, and pH. Sensory evaluation was carried out using a 9-point hedonic scale by a trained panel to assess texture, taste, appearance, and overall acceptability.

4. Results:

The formulated bread exhibited a low moisture content (2.62%), indicating good shelf stability and resistance to microbial spoilage. The ash content (1.29%) suggested the presence of essential minerals, while fat content was minimal (0.42%), making it suitable for low-fat dietary plans. A neutral pH confirmed the product's stability and consumer safety. Sensory evaluation revealed scores above 7 across all categories, confirming high consumer acceptance. Importantly, the inclusion of spinach did not adversely affect the taste or texture.

5. Conclusion & Recommendations:

This study successfully developed a functional, nutrient-rich focaccia bread with enhanced health benefits. The product combines low fat, mineral content, and sensory appeal, demonstrating its potential as a practical and appealing choice for consumers seeking healthier bakery options. Future research could explore shelf-life extension, antioxidant activity, and consumer studies across broader demographics. The findings support the growing trend toward functional foods and offer promising applications in the health-oriented bakery sector.

Keywords: Functional Bread, Spinach Powder, Dietary Fiber, Sensory Evaluation, Nutrition-enriched Bakery Product

Rethinking Food Security in the 21st Century: A Pathway Toward Resilient Agri-Food Systems

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1. Introduction:

Food security remains a critical global challenge, especially in developing countries like Pakistan, where agriculture sustains rural livelihoods but is threatened by climate change, economic instability, and rapid population growth. Traditionally defined by availability, access, utilization, and stability, food security now encompasses sustainability, nutrition, and equity. This paper emphasizes building resilient, inclusive food systems through climate-smart agriculture, precision farming, and digital innovations. Equally vital are investments in research, infrastructure, and value chains to reduce post-harvest losses, address rural-urban disparities, and strengthen smallholder livelihoods.

2. Objectives:

The objectives of this study are to: examine the evolving dimensions of food security in the 21st century; explore strategies for building resilient and sustainable agri-food systems; and evaluate the role of innovation, policy, and inclusion in addressing food insecurity in Pakistan and similar contexts.

3. Methodology:

This study employs a qualitative synthesis of recent global and national reports, peer-reviewed literature, and policy documents related to food security, sustainable agriculture, and One Health. A multidisciplinary lens was applied to identify emerging themes, gaps, and transformative strategies relevant to the Pakistani context.

4. Results:

The findings emphasize that food security challenges are interlinked with climate resilience, socioeconomic inequality, and systemic inefficiencies across production, distribution, and consumption. Inclusive policies, regional cooperation, and the empowerment of women and smallholder farmers emerged as critical enablers. Education, behavior change, and the integration of One Health principles were identified as underutilized yet vital strategies for future food systems.

5. Conclusion & Recommendations:

Ensuring food security in the 21st century requires more than increased agricultural output—it demands a fundamental transformation of agri-food systems. Policymakers must prioritize investments in climate-resilient technologies, foster inclusive governance, and promote interdisciplinary collaboration. Integrating nutrition, sustainability, and equity into food policy and practice is essential to secure a healthy and food-secure future for all.

Keywords: Food Security, Sustainable Agriculture, Climate Resilience, Policy Innovation, One Health

Innovation of Golden Jujube Shield Tea

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1. Introduction:

Ziziphus jujuba Mill., widely known as jujube or Chinese date, is an ancient fruit crop cultivated for more than 7,000 years and valued for its nutritional, medicinal, and cultural significance. A member of the Rhamnaceae family, it is remarkably tolerant to drought and salinity, making it well-suited to arid regions. Currently cultivated in over 48 countries, global production is led by China, which harvests more than 8 million tons annually (Zhao, 2021). Nutritionally, jujube is rich in vitamins (A, C, and B-complex), minerals, amino acids, and diverse phytochemicals such as flavonoids, triterpenoids, saponins, and phenolics. These bioactive compounds provide antioxidant, anti-inflammatory, anti-aging, and immune-modulatory properties, positioning jujube as a promising functional food and nutraceutical "super-fruit."

2. Objectives:

The objectives of this study are to: develop a functional herbal tea "Golden Jujube Shield Tea" using *Ziziphus jujuba* and complementary ingredients; and evaluate its nutritional profile, antioxidant activity, sensory acceptability, and potential health benefits.

3. Methodology:

Golden Jujube Shield Tea was formulated using dried jujube slices blended with complementary herbs (e.g., ginger, cinnamon, lemongrass) to enhance flavor and functional properties. Samples were tested for moisture, ash, total phenolic content (TPC), flavonoid content, and antioxidant activity (DPPH assay). A sensory evaluation was conducted using a 9-point hedonic scale with a panel of 30 semi-trained respondents.

4. Results:

The developed tea demonstrated significant antioxidant capacity, with high TPC and flavonoid levels attributed to jujube and synergistic herbs. The product received favorable scores in taste, aroma, and color during sensory trials, indicating good consumer acceptability. Nutritionally, the tea presented low calories, no caffeine, and was rich in bioactive compounds promoting immunity and metabolic balance.

5. Conclusion & Recommendations

Golden Jujube Shield Tea represents a promising innovation in the functional food market, combining ancient medicinal knowledge with modern nutritional science. It has strong potential for commercialization as a health-promoting beverage. Future research should focus on shelf-life stability, clinical validations, and scale-up production models.

Keywords: *Ziziphus jujuba Mill.*, Antioxidants, Phenolics, Flavonoids, Functional Tea, Traditional Medicine, Super-fruit, Oxidative Stress, Bioactive Compounds, Sensory Evaluation.

Role of Women in Canola Production in Punjab, Pakistan

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1. Introduction:

Women play a vital yet frequently underrecognized role in agriculture, contributing significantly to crop cultivation, livestock rearing, and post-harvest management, all while balancing extensive household responsibilities. Despite their central role in sustaining rural livelihoods, women's direct participation in field crop production, particularly in high-value oilseed crops such as canola, remains limited, underreported, and often constrained by social, cultural, and economic barriers. This study was designed to systematically evaluate women's involvement in canola production while identifying the key challenges restricting their active participation and potential empowerment.

2. Objectives:

The objectives of the study are to: quantify women's participation in canola production activities; evaluate the wage differentials between male and female labor; and identify the socio-cultural and economic barriers limiting women's engagement in the canola value chain.

3. Methodology:

The study was conducted in the Vehari district of Punjab, Pakistan. A purposive sampling technique was employed to collect primary data from 105 canola-growing households. Descriptive statistics were used to analyze labor participation, wage structures, and experience levels.

4. Results:

Findings indicated that most respondents were under 45 years of age. Over 80% relied on hired labor, with male laborers earning an average of Rs. 500/day compared to Rs. 416/day for female laborers. Monthly wages showed similar disparities: Rs. 13,569 for permanent male labor and Rs. 5,750 for female labor.

Women's participation in crop-related activities averaged just 2.47%, contributing only Rs. 131 per acre in monetary terms. However, in households with higher reported female involvement, participation reached up to 39%, amounting to Rs. 2,077 per acre.

Key barriers to female participation included cultural norms, lack of training, time constraints due to domestic responsibilities, fear of workplace harassment, the physical demands of farm labor, and the preference for abundant male labor.

5. Conclusion & Recommendations:

The study concludes that despite their potential, women remain significantly underrepresented in canola production due to social, economic, and institutional barriers. Policy interventions must focus on enhancing women's access to agricultural training, extension services, and financial resources. Addressing wage disparities and ensuring safe, inclusive workplaces can empower women, increase their contribution to household income, and promote gender equity. This, in turn, will positively impact rural livelihoods, reduce poverty, and strengthen food security.

Keywords: Female Labor, Wage Differential, Labor Participation, Gender Constraints, Food Security, Punjab

Black Gold Elixir: Development of a Nutritious Sweet Potato and Black Seed Oil Syrup

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1. Introduction:

This study presents *Aurum*, a functional syrup innovatively crafted by combining the natural sweetness and nutritional richness of sweet potatoes with the therapeutic properties of black seed oil (*Nigella sativa*). Sweet potatoes provide essential dietary fiber, vitamins, minerals, and natural sugars, offering sustained energy and improved digestive health. Black seed oil contributes potent antioxidants, anti-inflammatory, and potential anticancer benefits, widely recognized in traditional medicine. Marketed as the "Black Gold Elixir," this syrup delivers a nutrient-dense, immune-supporting alternative to conventional sugar syrups, aligning with modern demands for health-promoting, functional foods.

2. Objectives:

The objectives of this study are to: develop a stable and nutrient-rich syrup using sweet potatoes and black seed oil; evaluate the consistency, taste, and acceptability of the syrup; and ensure minimal nutrient degradation through optimized heat processing

3. Methodology:

The syrup was prepared using a low-heat evaporation method to preserve thermolabile nutrients such as vitamin C and phenolic compounds. Sweet potatoes were boiled and blended to extract juice, which was then combined with measured amounts of black seed oil and a small quantity of lemon juice for preservation. The mixture was simmered at low temperatures until the desired syrupy consistency was achieved. Physical characteristics (viscosity, color, consistency) and organoleptic properties (taste, aroma, texture) were evaluated through a sensory panel.

4. Results:

The resulting syrup exhibited excellent consistency, rich amber coloration, and a smooth texture. Sensory evaluations conducted among faculty members and peers indicated high acceptability, with appreciation for the natural sweetness and earthy flavor. Minimal nutrient loss was observed, and the syrup retained a pleasant balance between sweetness and the slightly pungent undertone of black seed oil. No phase separation or microbial spoilage was detected over a three-week shelf-life under refrigeration.

5. Conclusion & Recommendations:

The Black Gold Elixir syrup demonstrates promising potential as a nutritious, functional food product with immune-boosting and antioxidant benefits. It also offers a unique way to valorize sweet potatoes and promote the health benefits of black seed oil. Further studies are recommended to assess the product's nutritional profile, shelf stability, and potential health benefits through laboratory analyses and clinical trials. Commercial viability could be enhanced with improved packaging and market testing.

Keywords: Functional Syrup, Sweet Potato, Black Seed Oil, Antioxidants, Immune Support, Innovative Food Product

Sustainable Market Innovation in Functional Foods: Sugar-Free Bioactive Gummy Development for Agri-Food System Transformation and Enhanced Food Security

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1. Introduction:

The confectionery industry faces rising pressure to reduce sugar while adding functional benefits without compromising taste. Despite growing demand for sugar-free, bioactive-rich products, research on clean-label gummy formulations ensuring nutrition, stability, and acceptability remains limited. This study develops a sugar-free, fruit-based bioactive gummy, advancing functional innovation for agri-food transformation and food security.

2. Objectives:

To develop and characterize shelf-stable, sugar-free functional gummies using cranberry, cistanches, and strawberry extracts; and to evaluate their physicochemical, antioxidant, and sensory properties in comparison with commercial alternatives.

3. Methodology:

"Bright Berry Gummies" were developed using almond gum, glucomannan, and pectin with monk fruit extract as a natural sweetener, enriched with fruit powders and citric acid. Processing involved controlled heating, soaking, and pH adjustment to optimize gelling and bioactive retention. Quality evaluation included texture, rheological, physicochemical, and functional analyses. Shelf-life stability was assessed under ambient and frozen conditions, while sensory evaluation measured consumer acceptance of taste, texture, and overall appeal.

4. Results:

The sugar-free gummies outperformed commercial counterparts across nutritional, physicochemical, and sensory parameters. Antioxidant activity was markedly higher, with DPPH scavenging at 51.15% versus 12.3% and FCR absorbance at 1.183 versus 0.425 ($p<0.001$). Physicochemical analysis showed 10.68% moisture, 2.40% ash, 2.43% titratable acidity, and pH 5.88, supporting microbial stability. Gummies exhibited firmer texture (44.1 units), bright red coloration (a* 15.07), and reduced sugar (°Brix 10.92 vs. 24.5). Solubility improved with dissolution in 1.5 minutes versus 3.2. Sensory evaluation scored 8.1/10 versus 7.3, while shelf-life remained stable for 3 days at room temperature and 30 under freezing.

5. Conclusion & Implications:

This study presents a successful model for agri-food innovation through the development of sugar-free, bioactive gummies using fruit byproducts and natural additives. The product's superior nutritional and sensory profile, along with its clean-label and preservative-free composition, aligns with circular economy principles and supports food security by promoting fruit valorization and agricultural diversification. This scalable innovation can drive sustainable market shifts in functional snack alternatives.

Keywords: Functional Gummies, Sugar-free Confectionery, Cistanches, Agri-food Transformation, Canberry, Bioactive Ingredients

Agri-Food System Transformation Through Composite Flour Innovation: Enhancing Food Security via Nutritionally Fortified Pita Bread for Sustainable Market Dynamics

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1. Introduction:

The agri-food system must adapt to rising nutritional needs, particularly in regions reliant on wheat-based staples like pita bread. Such products often lack sufficient protein, fiber, and micronutrients despite growing awareness of diet-related health issues. This study addresses the gap by developing composite flour pita bread using locally available grains and pulses without compromising sensory quality.

2. Objectives:

To develop and evaluate composite pita bread enriched with barley and black lentil flour, assessing its nutritional profile, physicochemical properties, and sensory acceptance in comparison with conventional wheat-based pita bread.

3. Methodology:

Composite flours of wheat, barley, and black lentil were optimized to enhance the nutritional and functional quality of pita bread. Standardized production steps ensured consistency, while nutritional analysis quantified protein, fiber, fat, and ash using established protocols. Physicochemical properties, including expansion ratio, viscosity, water activity, retention capacities, and gluten concentration, were evaluated. Texture and loaf volume assessed structure, while sensory evaluation on a 9-point hedonic scale confirmed consumer acceptance of color, aroma, taste, and overall quality.

4. Results:

The incorporation of composite flour in pita bread significantly improved its nutritional and functional profile compared to the control. Protein content increased to 14.17% from 11.2% ($p<0.05$), while dietary fiber rose to 10.34% from 3.1%, and ash content reached 10.00% versus 1.8%. Fat content increased to 5.00% from 2.3%, with a slight rise in caloric value (275 vs. 265 kcal/100 g). Physicochemical properties also improved: expansion ratio (1.80 vs. 1.65), viscosity (26.08 vs. 22.5 MPa), and enhanced hydration capacities, while water activity reduced (0.63 vs. 0.68). Sensory evaluation confirmed consumer acceptability, validating its nutritional and market potential.

5. Conclusion & Implications:

This study highlights the potential of composite flour technology to improve the nutritional profile of widely consumed staple foods without compromising taste or texture. The enhanced pita bread formulation supports agri-food system transformation by leveraging underutilized local crops, such as barley and lentils, to address food insecurity and support agricultural diversification. With commercial-scale feasibility, this innovation can reshape market dynamics by delivering functional, affordable, and culturally relevant nutrition solutions.

Keywords: Composite Flour, Functional Pita Bread, Nutritional Fortification, Food Security, Barley, Black Lentil, Agri-food Transformation

Innovative Dehydrated Snack: Physicochemical and Nutritional Insights into Sweet Potato Jerky

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Introduction:

With the global shift toward sustainable, health-conscious, and plant-based diets, there is growing demand for innovative, nutrient-rich snack alternatives. This study explores the development, process optimization, and comprehensive evaluation of a novel sweet potato (Ipomoea batatas) jerky, a functional, eco-friendly, and shelf-stable snack. Orange-fleshed sweet potatoes, rich in beta-carotene, fiber, and complex carbohydrates, were selected for their nutritional advantages and natural sweetness.

Objectives:

To develop a dehydrated sweet potato jerky and assess its physicochemical, nutritional, microbiological, and sensory characteristics as a clean-label plant-based snack with commercialization potential.

Methodology:

Uniform sweet potato slices were marinated in soy sauce, maple syrup, liquid smoke, and spices to develop a plant-based jerky. Two dehydration methods, commercial drying at 57°C and convection oven drying at 80°C were optimized to achieve safe water activity (0.26) and moisture (0.75%). Analytical evaluations showed desirable texture (hardness 15.4 N, springiness 0.91), high carbohydrate content (82.8%), moderate protein (4.6%), 4.03% fiber, and strong antioxidant activity (DPPH 87.23%). Microbiological tests confirmed safety, while sensory evaluation scored 7.6/9, reflecting favorable consumer acceptance.

Results:

The final product demonstrated excellent sensory acceptability, favorable textural qualities (chewy, elastic), and significant nutritional value. It exhibited strong antioxidant potential and maintained structural integrity during rehydration, enhancing its functional versatility. Microbiological assessments confirmed safety and shelf stability.

Conclusion & Implications:

This study validates sweet potato jerky as a nutritious, shelf-stable, and sustainable plant-based snack alternative. With its low-fat content, high fiber and antioxidant levels, and appealing taste profile, it offers a viable substitute for meat-based jerky. Moreover, sweet potato cultivation requires significantly less water and emits fewer greenhouse gases, aligning with sustainability goals. The product holds strong commercialization potential, especially among health-conscious and younger consumers. Future research may explore protein fortification (e.g., with soy or pea protein), cultural flavor adaptations, and environmental life cycle assessments. Overall, sweet potato jerky emerges as a scalable, clean-label innovation that promotes healthier diets and supports agri-food system transformation.

Keywords: Sweet Potato Jerky, Plant-based Snack, Dehydration Technology, Nutritional Profiling, Shelf-life Extension, Food Innovation

Combating Iron Deficiency and Pica through a Functional Premix: A Food-Based Strategy Using Legumes and Leafy Greens for At-Risk Populations

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Introduction:

Iron deficiency remains one of the most widespread nutritional deficiencies globally, disproportionately affecting women and children in low-income communities. It not only contributes to anemia but is also associated with pica, a condition characterized by the craving and consumption of non-food substances. Tackling this issue through affordable, accessible, and nutrient-dense food-based interventions is crucial for improving public health outcomes.

Objectives:

This review investigates the nutritional potential of a functional food premix developed from spinach powder, chickpeas, and red kidney beans. The aim is to evaluate its efficacy in addressing iron deficiency and mitigate symptoms of pica, particularly in nutritionally vulnerable populations.

Methodology:

A comprehensive literature review was conducted to assess the individual and synergistic nutritional contributions of the selected ingredients. Processing techniques, including soaking, blanching, drying, and milling, were evaluated for their role in enhancing iron bioavailability and reducing anti-nutritional factors. The review also examined the effect of ascorbic acid inclusion and appropriate packaging strategies on product stability and ease of integration into daily diets.

Results:

The proposed premix presents a cost-effective and nutritionally rich source of plant-based iron, protein, dietary fiber, folate, and zinc. Spinach adds both iron and vitamin C, which aids in non-heme iron absorption. Legumes such as chickpeas and red kidney beans contribute additional iron and zinc, both essential in addressing iron deficiency and associated pica behaviors. Literature evidence supports the role of improved dietary iron intake in reducing pica prevalence. The premix also holds additional health benefits, including support for maternal health, improved digestion, and general malnutrition prevention.

Conclusion & Recommendations:

The spinach–chickpea–red bean premix demonstrates strong potential as a scalable, food-based strategy for combating iron deficiency and pica in at-risk communities. Its nutrient density, low cost, ease of preparation, and compatibility with community health programs position it well for integration into school feeding schemes, household diets, and public nutrition campaigns. Future research may focus on clinical trials to evaluate efficacy, and on product fortification or flavor enhancement to increase acceptance and long-term compliance.

Keywords: Iron Deficiency, Pica, Bioavailability, Legumes, Functional Food, Public Health Nutrition

Innovative Biodegradable Films for Enhanced Food Safety: A Study on Essential Oils

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1. Introduction:

Growing environmental concerns regarding plastic pollution have intensified the search for sustainable packaging alternatives. Natural polymers, particularly starch derived from renewable sources such as cassava, corn, and potato, offer a promising biodegradable solution. However, conventional starch-based films often lack antimicrobial functionality, limiting their effectiveness in preserving food safety. This study investigates the incorporation of essential oils into starch-based films to enhance their antimicrobial properties and functional performance for food packaging applications.

2. Objectives:

To develop and assess a biodegradable, antimicrobial film composed of plant-derived starch and natural essential oils. The goal is to create an eco-friendly packaging material that reduces plastic use, prevents microbial spoilage, and extends the shelf life of food products.

3. Methodology:

This laboratory-based experimental study focuses on the development of antimicrobial starch-based films. The process begins by gelatinizing starch through heat treatment and blending it with a plasticizer to improve film flexibility. Essential oils with established antimicrobial properties are then incorporated into the mixture. The film-forming solution is poured into sterile molds and dried under controlled conditions to ensure uniformity in the final product. All materials used in the formulation are commercially available and food-grade, ensuring safety and reproducibility. The resulting films are currently undergoing evaluation for various parameters, including physical properties such as tensile strength and elasticity, surface characteristics, and antimicrobial efficacy against common foodborne pathogens. As the project is still in the development phase, testing and refinement are ongoing.

4. Results:

Preliminary observations suggest that the films possess satisfactory structural integrity and uniform surface morphology. The incorporation of essential oils shows promising potential to inhibit microbial growth, indicating their usefulness in extending food shelf life. While full quantitative results are pending, early findings support the feasibility of this film as an effective and sustainable alternative to synthetic plastic packaging.

5. Conclusion & Recommendations:

This study highlights a novel and sustainable approach to food packaging by integrating natural antimicrobial agents into biodegradable starch-based films. The proposed solution addresses two critical challenges: reducing plastic waste and improving food safety without relying on synthetic preservatives. Upon successful validation through further testing, this technology could be adopted by the food industry to enhance packaging practices, contribute to public health, and align global sustainability and waste-reduction goals.

Keywords: Biodegradable Film, Essential Oils, Food Safety, Starch-based Packaging, Antimicrobial Packaging

Development of a Plant-Based High-Protein Nutritional Supplement for Sarcopenia Patients

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1. Introduction:

The rising prevalence of chronic diseases, driven by sedentary lifestyles and poor diets, has heightened concerns about sarcopenia, a progressive loss of muscle mass and function, affecting up to 40% of older adults and patients with chronic liver or cardiovascular conditions. Addressing this challenge requires affordable, accessible nutritional solutions. This study developed a high-protein supplement from locally available plant-based ingredients, offering a sustainable alternative to costly imported animal-based products for sarcopenia management.

2. Objectives:

To formulate a plant-based protein supplement for sarcopenia patients using soybeans, yellow split peas, oats, pumpkin seeds, and milk powder, and to assess its nutritional, textural, and sensory properties.

3. Methodology:

Formulations were prepared with varying concentrations of the selected ingredients. Proximate composition, mineral content, total phenolic content (TPC), total flavonoid content (TFC), texture profile analysis, and sensory evaluation were conducted. The data were statistically analyzed using ANOVA, with significance set at $p \leq 0.05$.

4. Results:

Formulations with higher soybean content, particularly Treatment 1 (T1), showed substantial nutritional enhancement. Protein, crude fiber, ash, fat, total phenolic content (TPC), and total flavonoid content (TFC) all increased significantly. Soybean flour contributed the highest mineral values, including calcium (86.34 mg/100g), sodium (203.17 mg/100g), magnesium (128.12 mg/100g), and zinc (3.66 mg/100g). Pumpkin seeds provided maximum iron (6.91 mg/100g), while yellow split peas offered the richest potassium (847 mg/100g). Protein peaked in T1 at 20.02 g/100g, rising with soybean inclusion. Texture analysis indicated greatest hardness, while sensory evaluation favored T1 for appearance, taste, texture, and overall acceptability.

5. Conclusion & Recommendations:

The developed soy-based high-protein supplement demonstrated promising nutritional and sensory characteristics suitable for managing sarcopenia. Given its affordability, sustainability, and local ingredient sourcing, this product has strong potential for commercial-scale production. It can serve as a cost-effective alternative to imported protein formulations in public health nutrition programs targeting elderly and chronically ill populations.

Keywords: Sarcopenia, Muscle Loss, Plant-based Protein, Soybeans, Nutritional Supplement, Geriatric Health

Development of Gluten-Free Brownies Enriched with Barley and Red Kidney Bean Flour

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1. Introduction:

This study focuses on the development of a functional gluten-free bakery product, Barley Bean Brownie, by incorporating barley flour and red kidney bean flour as nutritious alternatives to refined wheat flour. Barley flour is a rich source of β-glucan (a soluble dietary fiber) known to support cardiovascular and digestive health. Red kidney bean flour offers plant-based protein, iron, and resistant starch, which can help regulate blood glucose and support muscle recovery. This formulation aims to meet the dietary needs of health-conscious consumers seeking fiber- and protein-rich snacks without refined flour or gluten.

2. Objectives:

The objectives of this study are to: develop a gluten-free brownie using barley and red kidney bean flour; enhance the nutritional profile of brownies without compromising sensory properties; and evaluate the product's suitability as a functional food with commercial potential.

3. Methodology:

Four formulations were developed by varying the ratios of barley flour and red kidney bean flour, replacing refined wheat flour entirely. The brownies were evaluated for proximate composition (protein, fat, fiber, carbohydrate, moisture, ash), texture profile, and sensory attributes including appearance, taste, texture, and overall acceptability using a 9-point hedonic scale. All tests were conducted in triplicate, and statistical analysis was performed using ANOVA at a 5% significance level.

4. Results:

The formulation containing 50% barley flour and 50% red kidney bean flour showed a significant increase in protein and dietary fiber compared to a control sample. The β-glucan content of barley enhanced the moisture retention and softness of the brownies, while red kidney bean flour contributed to a denser texture and mild nutty flavor. Sensory evaluation indicated high acceptability, particularly in terms of taste and mouthfeel, with no significant compromise in consumer preference compared to traditional brownies.

5. Conclusion & Recommendations:

The study successfully developed a gluten-free, nutrient-dense brownie using barley and red kidney bean flour. The product offers functional health benefits, aligns with dietary trends, and is suitable for individuals with gluten intolerance or those seeking clean-label snack options. It has strong potential for commercialization in the nutraceutical, functional foods, and bakery sectors. Future work should explore shelf-life stability and consumer perception on a larger scale.

Keywords: Gluten-free, Functional Food, Barley Flour, Red Kidney Bean Flour, β-glucan, Brownies, Plant-based Protein, Resistant Starch.

Salinization of Agricultural Soils: Innovations for Functional and Sustainable Restoration of Degraded Land

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1. Introduction:

Soil salinity is a major abiotic stress limiting agricultural productivity and driving land degradation, with 1.381 billion hectares (10.7% of Earth's land) affected worldwide. Yield losses can exceed 70%, posing a critical threat to food security, especially in vulnerable regions. Conventional remediation methods such as drainage, gypsum, or lime offer temporary relief but are costly, resource-intensive, and unsuited to smallholder systems. In contrast, sustainable strategies like phytoremediation, biochar application, beneficial microbes, and cover cropping address root causes, improve soil fertility and structure, and enhance biological activity. These holistic solutions align with agroecology, biodiversity conservation, and building resilient food systems.

2. Objectives:

This study aims to: assess the extent and impact of soil salinization on agricultural productivity; evaluate the limitations of conventional remediation methods; and highlight promising innovations (biological, ecological, and agronomic) for restoring salinized soils in a sustainable and functional manner.

3. Methodology:

A review-based and analytical approach is employed, synthesizing scientific literature, case studies, and experimental findings related to soil salinity management and ecological restoration technologies.

4. Results:

Preliminary analysis indicates that combining phytoremediation with microbial inoculants offers a highly effective approach to managing soil salinity. This integrated strategy not only enhances crop tolerance to saline conditions but also improves soil microbial diversity, fertility, and nutrient cycling. Moreover, it contributes to the gradual restoration of degraded land while being cost-effective and environmentally sustainable, making it a practical solution for smallholder farmers and resource-constrained agricultural systems.

5. Conclusion & Recommendations:

Salinization is a growing threat to global food systems, especially in arid and semi-arid regions. Transitioning from chemical-intensive remediation to nature-based, agroecological practices is essential for sustainable land management. Policymakers and development stakeholders should promote the adoption of bio-based innovations and invest in research-extension linkages to support smallholder farmers in restoring saline soils.

Keywords: Soil Salinization, Land Degradation, Sustainable Agriculture, Phytoremediation, Beneficial Microorganisms, Agroecology

Development and Evaluation of Milk Thistle Kombucha: A Functional Fermented Beverage with Hepatoprotective Potential

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1. Introduction:

Milk thistle (*Silybum marianum*) is a medicinal plant renowned for its hepatoprotective and antioxidant properties, primarily due to its bioactive compound silymarin. Kombucha, a fermented tea beverage, has gained popularity for its functional benefits including antioxidant, detoxifying, and probiotic effects. This study investigates the potential of milk thistle kombucha (MTK) as a novel functional beverage with enhanced health benefits.

2. Objectives:

To develop and evaluate milk thistle-infused kombucha by examining its biochemical, microbiological, and sensory attributes, and compare its functional quality with conventional black tea kombucha.

3. Methodology:

Black tea served as the fermentation substrate, supplemented with milk thistle extract at 1%, 2%, and 4% (v/v) across separate batches, while a traditional kombucha without extract acted as the control. Fermentation was carried out with a symbiotic culture of bacteria and yeast (SCOBY) at 28°C for 14 days. Samples collected on days 0, 7, and 14 were analyzed for total phenolic content (TPC) using the Folin–Ciocalteu method and antioxidant activity via DPPH assay. Microbial counts of yeast and acetic acid bacteria, along with pH monitoring, ensured safety. Sensory evaluation with 30 untrained panelists assessed overall acceptability.

4. Results:

MTK samples exhibited significantly higher antioxidant activity and TPC compared to the control ($p < 0.05$). The 2% extract sample showed the highest DPPH scavenging activity (67.5%). A steady decline in pH was observed across all samples, reaching approximately 2.9 by day 14, indicating successful fermentation. Microbial counts confirmed robust activity with no adverse effect from the extract addition. Sensory results showed that the 2% MTK variant was most favored, scoring an average of 7.6 for overall acceptability, reflecting a favorable balance of medicinal notes and palatability.

5. Conclusion & Recommendations:

Incorporating milk thistle extract into kombucha fermentation enhances its functional and antioxidant properties without compromising microbial integrity or consumer acceptability. MTK emerges as a promising functional beverage, particularly for liver support and antioxidant defense. Further studies are recommended to explore its shelf stability, bioavailability, and clinical efficacy through human trials.

Keywords: Milk Thistle Kombucha, Antioxidant Activity, Functional Beverage, Fermentation, Hepatoprotective Effects

Examining the Correlation Between Eating Posture, Meal Location, and Weight Management Among Teenagers Aged 15–19 Years in Faisalabad

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1. Introduction:

Adolescence is a critical period for establishing lifelong dietary and lifestyle habits. This study investigates the relationship between eating posture, meal location, dietary behaviors, lifestyle patterns, and their potential influence on weight status among teenagers aged 15 to 19 in Faisalabad, Pakistan.

2. Methodology:

A descriptive cross-sectional study was carried out among 100 adolescents recruited through non-probability sampling. Data collection employed a structured questionnaire designed to capture diverse lifestyle and dietary variables, including meal-time posture, preferred eating location, frequency and type of food intake, and level of physical activity. Body mass index (BMI) classification was also assessed.

3. Results:

The most common eating postures were sitting cross-legged (37%) and upright at a dining table (34%), while 25% reported eating in relaxed positions such as on couches or beds. A significant association was observed between eating posture and meal frequency ($p < 0.05$). Additionally, poor posture during meals was linked to physical discomfort, such as back pain and bloating ($p = 0.02$).

Although the location of meals (home, school, or on-the-go) showed no significant correlation with BMI, participants with regular meal timings were less likely to snack frequently ($p = 0.019$). Consumption of fast food ($p = 0.033$) and sugary beverages ($p = 0.040$) was significantly associated with unhealthy dietary behaviors. Moreover, physical activity levels were strongly correlated with weight management efforts ($p = 0.000$). While most lifestyle factors did not show a significant direct correlation with BMI, dietary behaviors had a near-significant association ($p = 0.0787$), indicating a possible role in weight regulation.

4. Conclusion & Recommendations:

The findings suggest that structured eating routines, proper meal-time posture, and increased physical activity can positively influence adolescents' weight-related outcomes. Although the associations with BMI were not all statistically significant, patterns in eating behavior, posture, and physical activity underscore their potential importance in adolescent health. Further studies with larger, more diverse samples and standardized anthropometric measures are recommended to validate and expand upon these results.

Keywords: Eating Posture, Meal Setting, Dietary Patterns, Lifestyle Behaviors, Weight Outcomes, Teenagers

Collagen-Enriched Gummies for Enhanced Skin and Joint Health: A Comparative Study of Multi-Source Collagen and Aloe Vera Integration

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1. Introduction:

The rising demand for functional foods and nutraceuticals reflects consumer interest in natural solutions for skin, joint, and bone health. Gummies offer a convenient and appealing alternative to powders or tablets, with collagen widely recognized for improving skin hydration, reducing wrinkles, and supporting cartilage repair. Despite this potential, collagen-based gummies remain underexplored in Pakistan, and comparative studies are scarce. This study developed and evaluated collagen-enriched gummies incorporating rice, fish, poultry, and bovine collagen, combined with aloe vera for added moisturizing benefits.

2. Objectives:

The objectives of this study were to develop a novel multi-source collagen gummy supplemented with aloe vera extract, to compare plant-based (rice) and animal-based (fish, poultry, and bovine) collagen in terms of bioavailability and functional benefits, and to assess consumer acceptability, flavor, texture, and overall market potential within the context of Pakistan's emerging nutraceutical industry.

3. Methodology:

Four collagen-enriched gummy formulations were prepared using rice, fish, poultry, and bovine collagen, each blended with a standardized aloe vera extract. Physicochemical analyses (moisture content, water activity, texture) assessed stability and consistency. Bioavailability was tested through in vitro digestion to evaluate peptide release and absorption, while simulated gastrointestinal uptake assessed functional performance. Sensory evaluation by 50 panelists provided insights into consumer preference and market potential.

4. Results:

Fish-derived collagen demonstrated the highest peptide bioavailability (≈85%, $p < 0.01$), followed by poultry, bovine, and rice collagen. Participants who consumed fish collagen gummies reported noticeable improvements in skin hydration, joint flexibility, and reduced discomfort after four weeks. Aloe vera addition contributed positively to digestion and perceived skin suppleness. Among all variants, fish collagen gummies scored highest in sensory evaluations for taste, mouthfeel, and overall preference.

5. Conclusion & Recommendations:

Multi-collagen gummies enriched with aloe vera offer a convenient approach to promoting joint and skin health. Among sources, fish collagen demonstrated superior absorption and sensory qualities, making it promising for future development. In Pakistan's growing nutraceutical market, such products could address nutritional gaps, with clinical trials and awareness campaigns essential for wider adoption.

Keywords: Collagen, Nutraceutical, Joint Health, Bioavailability, Aloe Vera, Skin Hydration, Functional Foods

Factors Affecting the Net Export of Chickpeas in Pakistan

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1. Introduction:

Chickpeas (*Cicer arietinum L.*) are one of Pakistan's most economically and nutritionally important pulse crops, contributing to national food security and the livelihoods of rural communities. Despite favorable agro-climatic conditions and production potential, Pakistan's chickpea export performance remains inconsistent due to a range of structural and policy-related challenges. This study investigates the key factors influencing the net export of chickpeas from Pakistan.

2. Objectives:

To assess the quantitative and qualitative determinants affecting chickpea export performance and provide policy recommendations for strengthening Pakistan's presence in global pulse markets.

3. Methodology:

A mixed-methods approach was adopted. Quantitative data covering the period 2013–2023 were obtained from official government publications and international trade databases. Analytical tools included descriptive statistics, correlation analysis, and multiple linear regression to assess the effects of production levels, exchange rates, and international prices on net exports. Qualitative insights were derived from semi-structured interviews with 50 stakeholders, comprising farmers, exporters, and agricultural policy experts, and analyzed them thematically.

4. Results:

Quantitative analysis revealed that chickpea production significantly and positively influenced net exports, while exchange rate volatility had a negative effect. International prices showed a moderate impact, highlighting the importance of market competitiveness. Thematic analysis identified several on-ground constraints, including high input costs, low seed quality, climate variability, inconsistent trade policies, poor documentation, and limited awareness of government export incentives. Additionally, inadequate infrastructure and market intelligence were found to be major bottlenecks to export efficiency.

5. Conclusion & Recommendations:

To enhance the net export performance of chickpeas, a multi-pronged strategy is essential, focusing on improving production systems, stabilizing trade policy, expanding market access, and strengthening institutional and infrastructural support. Policy interventions should prioritize affordable inputs, certified seed distribution, stable exchange rate mechanisms, streamlined documentation, and farmer education on export incentives. These measures can collectively boost Pakistan's competitiveness in the global pulse market and promote sustainable agricultural trade development.

Keywords: Chickpea, Net Exports, Production, Exchange Rate, Trade Policy, Market Access, Pakistan

Banana Production and Export Development in Somalia (1961–2022)

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1. Introduction:

Bananas (*Musa sapientum*), belonging to the Musaceae family, are among the world's most important fruits, cultivated across equatorial and subtropical regions. Grown on about 8.8 million hectares globally, they rank as the fourth key food crop after rice, wheat, and maize. Nutritionally, bananas are rich in potassium, natural sugars, protein, and vitamins A, B, C, and G, while also holding cultural and economic value. In Somalia, once a leading producer, banana output has sharply declined. This study reviews production and export trends (1961–2022), analyzes underlying challenges, and proposes strategies for sector revival.

2. Objectives:

The objectives of this research are to: analyze historical trends in banana production and exports in Somalia; assess the key factors contributing to the sector's decline; and propose policy and practical measures for sustainable recovery and growth.

3. Methodology:

The study employs a historical trend analysis using secondary data from FAO, national agricultural statistics, and international trade databases covering the period from 1961 to 2022. Quantitative metrics such as production volume, yield, harvested area, and export trends were analyzed, along with a comparative review of global banana production and export performance.

4. Results:

Somalia's banana production increased from 98,000 tons in 1961 to 110,000 tons in 1980 but sharply declined to 23,610 tons by 2022, a 78.54% reduction from peak levels. Similarly, the harvested area decreased from 2,300 ha to 1,384 ha. Although yield rose from 89,091 kg/ha in 1961 to 286,327 kg/ha in 1980, it later declined to 170,606 kg/ha by 2022. Factors contributing to this decline include adverse climatic conditions, outdated farming techniques, lack of infrastructure, and weak export market linkages.

5. Conclusion & Recommendations:

The banana sector in Somalia presents significant potential for revival, offering pathways to strengthen food security, enhance rural livelihoods, and boost trade across the Horn of Africa. Achieving this requires strategic interventions such as introducing improved, disease-resistant banana varieties through targeted breeding programs and implementing nutrient management practices to restore soil fertility. Equally vital are efforts to strengthen value chains, improve export infrastructure, and enhance market access. Farmer education and capacity-building will ensure sustainable production, while supportive policies promoting climate-resilient agriculture can safeguard long-term viability. Revitalizing Somalia's banana industry could transform economic recovery and foster regional trade integration.

Keywords: Somalia, Banana Production, *Musa sapientum*, Export Development, Yield Trends, Agricultural Policy

Enhancing Food Security through Nutritionally Enriched Gluten-Free Biscuits Using Maize and Sweet Potato Blends

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1. Introduction:

The growing prevalence of gluten intolerance and the global emphasis on inclusive and functional foods have intensified the demand for gluten-free alternatives. Addressing both health and food security concerns, this study focused on the development of nutritionally enhanced, gluten-free biscuits using blends of maize flour and sweet potato paste—two climate-resilient and underutilized crops widely available in the Global South.

2. Objectives:

To formulate and evaluate gluten-free biscuits using various combinations of maize flour and sweet potato paste, with the aim of improving nutritional value, sensory appeal, and food security potential.

3. Methodology:

Six biscuit formulations were developed, including one wheat-based control. The experimental treatments used varying ratios of maize flour and sweet potato paste. All samples were subjected to physical, chemical, nutritional, and sensory evaluations. Key parameters analyzed included moisture, protein, fiber, ash content, calorific value, spread ratio, and sensory attributes (color, texture, taste, and overall acceptability), assessed using a 9-point hedonic scale.

4. Results:

The formulation T4 (50% maize flour + 50% sweet potato paste) proved to be the most preferred among all treatments, achieving the highest sensory scores for taste, texture, aroma, and overall acceptability. Nutritionally, T4 demonstrated significant improvements, with higher fiber and ash content, moderate protein levels, and an energy value comparable to the control, ensuring both balance and consumer appeal. These results highlight the dual functional and nutritional advantages of this composite blend, emphasizing its potential in addressing dietary gaps while promoting gluten-free product diversification and innovation in emerging markets.

5. Conclusion & Recommendations:

The development of gluten-free biscuits using maize and sweet potato blends presents a promising approach to enhancing dietary diversity and food security, particularly in resource-limited settings. Promoting the use of such alternative crops can contribute to sustainable agri-food system transformation and broaden access to nutritious, allergen-friendly food products. Further research should explore shelf-life stability, scalability, and cost-effectiveness for commercial applications.

Keywords: Gluten-free Biscuits, Maize Flour, Sweet Potato, Food Security, Sensory Evaluation, Agri-food Transformation

Enhancing Respira Naturals: Revolutionizing Respiratory Relief with an Eco-Friendly Organic Vapor Rub

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1. Introduction:

Rising awareness of the harmful effects of synthetic ingredients in conventional remedies, such as petrochemical-based vapor rubs, has increased demand for natural, eco-friendly alternatives. Traditional formulations often cause allergic reactions or skin irritation, encouraging a shift toward safer plant-based options. Essential oils like eucalyptus (rich in 1,8-cineole), peppermint (high in menthol), and lavender offer antibacterial, anti-inflammatory, decongestant, and soothing properties. This study aims to develop a safe, effective, and sustainable vapor rub using these oils, beeswax, and coconut oil as base components.

2. Objectives:

The objectives of this study are to: develop a biocompatible and eco-friendly organic vapor rub using natural ingredients; assess its physical stability, topical safety, and user acceptability in terms of texture, aroma, spreadability, and perceived therapeutic effects; and evaluate its microbiological safety and shelf stability over 30 days.

3. Methodology:

The vapor rub was prepared by melting beeswax and coconut oil using a double boiler method, followed by sterilization and incorporation of essential oils (eucalyptus, peppermint, lavender). The final product was poured into molds and allowed to set. The rub underwent pH testing, microbial analysis (total viable count), 30-day stability observation, and sensory evaluation by a consumer panel. The pH value of 5.5 confirmed skin compatibility. Microbiological testing showed colony counts well below acceptable thresholds (<20 CFU/g), ensuring product safety. Sensory evaluation assessed fragrance, texture, spreadability, and cooling effect.

4. Results:

The product demonstrated consistent physical and sensory stability over 30 days. The mildly acidic pH aligned with skin tolerance standards. Sensory panel results were positive, with users reporting a soothing fragrance, smooth application, and immediate cooling sensation. The low microbial load confirmed the product's safety without chemical preservatives. These findings validate the potential of this formulation as a natural alternative for respiratory relief.

5. Conclusion & Recommendations:

The study confirms that a vapor rub formulated from essential oils and natural bases like beeswax and coconut oil can provide effective respiratory relief without relying on petroleum-derived ingredients. The product combines holistic therapeutic benefits with consumer appeal and environmental sustainability. It holds promise for commercialization as a natural over the counter (OTC) solution. Further clinical validation, shelf-life studies, and scalability assessments are recommended to enhance market readiness.

Keywords: Essential Oils, Holistic Intervention, Natural Therapeutics, Organic Vapor Rub, Olfactory Pathways, Respiratory Relief

Investigation of Consumer Knowledge and Understanding of Nutrition Labeling on Pre-Packaged Foods in Marts of Faisalabad

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1. Introduction:

Nutrition labeling is crucial for promoting healthier dietary choices amid rising obesity, diabetes, and cardiovascular diseases. The World Health Organization advocates front-of-pack nutrition labeling (FOPNL) to support informed decision-making. However, limited comprehension and low literacy reduce its effectiveness. Clear, accessible labeling is essential to empower consumers and improve public health. This study examined consumer knowledge, attitudes, and practices regarding nutrition labels in Faisalabad, with a focus on how educational background influences food selection behavior.

2. Objectives:

The objectives of this study are to: evaluate consumer awareness and understanding of nutrition labeling on packaged foods; assess the relationship between education level and interpretation/use of food labels; and identify key factors influencing the reading and utilization of nutritional information.

3. Methodology:

A cross-sectional survey was conducted using a structured questionnaire administered via in-person interviews. A total of 200 participants were selected from various marts across Faisalabad using convenience sampling. The questionnaire assessed label-reading behavior, interpretation ability, and the perceived usefulness of nutrition labels. Data were analyzed using descriptive statistics and cross-tabulation to identify significant associations.

4. Results:

The study found that 60% of participants regularly read nutrition labels and understood their purpose, with calories ranked as the most relevant information, followed by serving size, protein, sugar, and fat. While 90% believed labels support healthier choices, 58% reported difficulty interpreting them, reflecting a knowledge gap. Most respondents distinguished between “Best Before” and “Expiry Date” and occasionally checked allergens or dietary restrictions. Higher education was positively associated with better label comprehension, though some participants criticized the excessive technical detail, reducing overall usability and effectiveness.

5. Conclusion & Recommendations:

The study highlights nutrition labeling as a valuable tool for healthier diets but reveals major gaps in comprehension. Improving outcomes requires simplified formats with visual cues (e.g., traffic light or health star ratings), consumer education to enhance label literacy among vulnerable groups, and stronger policies to regulate and standardize front-of-pack labeling in Pakistan. Future research should examine labeling impacts, system effectiveness, and socio-cultural influences.

Keywords: Nutrition Labeling, Consumer Knowledge, Dietary Behavior, Public Health, Label Comprehension, Food Choice Determinants

Farmer Perceptions and Barriers to the Adoption of UAV Technology in South Punjab, Pakistan

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1. Introduction:

Technological advancements have the potential to significantly enhance the livelihoods of rural communities by increasing agricultural productivity, improving decision-making, and reducing dependency on manual labor. Among these innovations, Unmanned Aerial Vehicles (UAVs) are gaining global attention for their ability to collect real-time, high-resolution data on crop health, soil conditions, and field variability. These insights can support precision farming practices, optimize input use, and improve yield outcomes. However, in developing countries like Pakistan, the adoption of UAV technology remains limited due to various socio-economic and infrastructural barriers.

2. Objectives:

This study aims to explore farmers' perceptions of UAV technology and identify the key obstacles hindering its adoption in the agricultural sector of South Punjab. Despite its potential, the uptake of UAVs remains under-researched, particularly in rural Pakistan where awareness, affordability, and institutional support are often lacking. Specific objectives are to: assess farmers' awareness and perceptions regarding the use of UAVs in agriculture; identify and analyze the key barriers to UAV adoption among farmers in District Multan, South Punjab; and provide policy recommendations for enhancing the adoption of smart technologies in smallholder farming systems.

3. Methodology:

Primary data will be collected from a sample of 200 farmers using a structured questionnaire. Respondents will be selected through simple random sampling across rural areas of District Multan. The study will apply appropriate econometric methods using statistical software (e.g., STATA or SPSS) to analyze factors influencing UAV adoption, including socioeconomic variables, knowledge levels, cost-related constraints, and institutional support mechanisms.

4. Results (Expected):

The study anticipates identifying significant perception-based and structural barriers, such as lack of technical knowledge, high initial investment costs, limited training opportunities, and weak extension services. It is expected that farmers with higher education, access to information, and larger farm holdings will exhibit a more favorable perception towards UAV adoption.

5. Conclusion & Recommendations:

This research will offer valuable insights for policymakers, development agencies, and commercial stakeholders by highlighting the importance of targeted subsidies, awareness campaigns, and capacity-building programs to promote UAV adoption. It will also inform future research on the role of sustainability-driven incentives and technology diffusion in rural farming systems.

Keywords: Unmanned Aerial Vehicles (UAVs), Technology Adoption, Farmer Perception, Barriers, Precision Agriculture, South Punjab

The Impact of Connectivity and Competitiveness on E-Commerce Growth: Evidence from Selected South and Southeast Asian Countries

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1. Introduction:

Internet connectivity and national competitiveness are key drivers of e-commerce growth, especially in emerging economies. Connectivity indicates the availability and quality of digital infrastructure, while competitiveness reflects a country's ability to leverage digital tools for innovation and economic development. E-commerce growth encompasses increasing online transactions, sales, and platform activity. This study examines the impact of connectivity and competitiveness on e-commerce expansion across South and Southeast Asia, regions experiencing rapid digital transformation but facing infrastructure and competitiveness gaps.

2. Objectives:

The objectives of the study are to: analyze the effect of internet connectivity on e-commerce growth; examine the role of national competitiveness, measured through the Global Competitiveness Index (GCI), in influencing digital commerce expansion; and identify other contributing factors such as GDP per capita, mobile penetration, social media usage, and infrastructure quality.

3. Methodology:

The study analyzes panel data from eight countries—India, Pakistan, Bangladesh (South Asia) and Indonesia, Malaysia, Thailand, Singapore, and the Philippines (Southeast Asia)—for 2010–2024. Variables include internet connectivity, e-commerce growth, GCI score, GDP per capita, mobile penetration, social media usage, infrastructure index, and platform usability. A fixed-effects regression model was employed to control country-specific heterogeneity and isolate variable impacts on e-commerce growth.

4. Results:

The empirical findings reveal a statistically significant and positive relationship between internet connectivity and e-commerce growth. Similarly, a higher GCI score is associated with enhanced performance in digital commerce, emphasizing the importance of institutional and infrastructural competitiveness. Additional variables such as mobile penetration and social media usage were also found to positively influence e-commerce adoption across countries, while disparities in digital infrastructure remained a limiting factor in low-income nations.

5. Conclusion & Recommendations:

The study concludes that enhancing internet connectivity and national competitiveness is vital for e-commerce growth in South and Southeast Asia. Policy priorities include digital infrastructure, regulatory reforms, and literacy programs. Governments should also foster cross-border cooperation and private-sector innovation to build inclusive digital economies, offering actionable insights for policymakers, development agencies, and digital entrepreneurs.

Keywords: E-Commerce Growth, Internet Connectivity, Global Competitiveness Index, South and Southeast Asia, Fixed Effects Model

Role of AI and Mobile Advisory Tools in Digital Agriculture: An Extension-Led Approach in Punjab, Pakistan

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1. Introduction:

Digital agriculture is transforming extension services by using AI and mobile advisory tools to improve decision-making, optimize inputs, and increase farm productivity. In Pakistan, where smallholders dominate, adoption of AI-driven technologies is crucial for sustainable, climate-resilient farming. Despite studies on SMS-based advisories, little evidence exists on smallholders' awareness, adoption, and effectiveness of AI tools, and the role of extension agents in promoting digital uptake remains underexplored.

2. Objectives:

Objectives of the study are to: assess the awareness, accessibility, and usage of AI-based mobile advisory applications among smallholder farmers in Punjab; identify key adoption barriers and enabling factors for tools such as *Plantix*, *Tabeer*, *BaKhabar Kissan*, *Kissan-360*, *Digital Dera*, and *AgriSmart; and* evaluate the role of extension agents, researchers, and app developers in supporting digital agriculture adoption.

3. Methodology:

The study was conducted in four Punjab districts, Muzaffargarh, Rahim Yar Khan, Attock, and Rawalpindi. A total of 160 farmers were surveyed using multistage random sampling, while 22 stakeholders, including extension personnel, researchers, and developers, were interviewed purposively. Data were collected via structured questionnaires and key informant interviews, analyzed using descriptive and thematic methods.

4. Results:

The findings reveal that 72% of farmers use mobile phones, but only 28% actively engage with advisory apps. Popular services included weather forecasts (80%), pest alerts (54%), market prices (49%), and crop guidance (42%), with BaKhabar Kissan most favored. Adoption barriers included low digital literacy, poor connectivity, limited regional language support, and mistrust of AI. Experts stressed communication, real-time decision-making, local validation, user-friendly interfaces, and data accuracy as key adoption factors.

5. Conclusion & Recommendations:

AI-powered mobile tools can enhance agricultural extension in Pakistan. The study recommends improving digital literacy among farmers, localizing apps with language and context-relevant content, fostering public-private collaboration to integrate AI tools into extension systems, and implementing evidence-based policies to sustainably scale digital innovations across the agricultural sector.

Keywords: Agricultural Extension, Digital Agriculture, Artificial Intelligence, Mobile Advisory, Precision Farming, Farmer Decision-Making

Leveraging Artificial Intelligence for Sustainable Fisheries in Pakistan: Advancing Food Security, Livelihoods, and Market Access

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1. Introduction:

Pakistan's 1,120-km coastline and inland aquatic resources provide about 4% of national protein and support 1.8 million livelihoods. The fisheries sector faces sustainability challenges, including overfishing, IUU practices, habitat degradation, inefficient value chains, and fragmented governance. These issues deplete stocks, raise prices, limit access for low-income groups, and constrain exports. Despite the 2022 Fisheries Development Policy, weak law enforcement, inadequate cold-chain infrastructure, and poor sanitary compliance continue to impede progress.

2. Objectives:

This study explores the transformative role of Artificial Intelligence (AI) in overcoming structural and operational challenges in Pakistan's fisheries sector, particularly in enhancing sustainability, improving monitoring, ensuring traceability, and strengthening food security and livelihoods.

3. Methodology:

The research applies a qualitative review and analytical synthesis of existing AI applications in global fisheries, benchmarking them against current gaps in Pakistan's fisheries systems. Policy frameworks, technological use-cases (e.g., biofloc systems, predictive modelling), and market constraints are analyzed through a multidisciplinary lens to assess the potential for localized adaptation.

4. Results:

AI integration offers multiple intervention points in fisheries management. Drones and satellite imagery enable real-time IUU fishing detection and fish stock assessment, while image recognition and sensor technologies support early disease detection, feeding efficiency, and water quality monitoring. Machine learning predicts stock fluctuations, sets sustainable harvest limits, and issues climate warnings. AI also enhances HACCP compliance, cold-chain logistics, traceability, and price transparency. Challenges include data scarcity, high infrastructure costs, sensor reliability, and limited digital literacy. Affordable AI tools, federated learning, blockchain traceability, and targeted capacity-building are recommended to overcome these barriers.

5. Conclusion and Recommendations:

AI-enabled fisheries management offers a strategic pathway to ensure ecological sustainability, fair market participation for small-scale fishers, improved nutritional outcomes, and increased resilience to climate change. The study recommends integrating AI into national policy frameworks through multi-stakeholder partnerships and investment in infrastructure and training. Prioritizing ethical AI governance and inclusive access will be critical to realizing the sector's full potential.

Keywords: AI-Powered Aquaculture, Sustainable Fisheries, Food Security, IUU Monitoring, Climate Resilience, Market Transparency, Traceability Systems

Iron Oxide Nanoparticles Mediated Salinity Stress Mitigation in Jalapeño Plant

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1. Introduction:

Salinity is among the most critical abiotic stresses restricting agricultural productivity worldwide, with its prevalence in Pakistan increasing due to both natural processes and unsustainable land and water management practices. It disrupts plant growth, reduces yield, and degrades soil quality. Recent advances in nanotechnology, particularly micronutrient-based nanoparticles (NPs), offer innovative strategies to enhance crop resilience under stress. This study investigates the potential of eco-friendly, green-synthesized iron oxide nanoparticles (IONPs) in alleviating salinity-induced damage and improving growth performance in jalapeño (Capsicum annuum L.) plants.

2. Objectives:

The objectives of this study are to: assess the effects of foliar-applied IONPs on growth, biochemical attributes, and yield of jalapeño under varying salinity levels.

3. Methodology:

A controlled pot experiment, arranged in a completely randomized design, evaluated the effects of four NaCl concentrations (0, 50, 100, 150 mM) and four foliar-applied IONP levels (0, 100, 200, 300 ppm), both individually and in combination. Green-synthesized IONPs from cucumber extract were comprehensively characterized using DLS, UV–Vis spectroscopy, FTIR, XRD, and SEM techniques.

4. Results:

Salinity stress caused significant reductions in growth, biochemical, and yield parameters of jalapeño plants, with the most pronounced decline at 150 mM NaCl. Foliar application of iron oxide nanoparticles (IONPs) enhanced all measured traits under both stressed and non-stressed conditions, with 300 ppm proving most effective. Antioxidant activity was significantly increased, while oxidative stress markers, including malondialdehyde (MDA) and hydrogen peroxide (H_2O_2), were markedly reduced, indicating improved stress tolerance and overall plant health. These findings highlight the potential of IONPs to mitigate salinity-induced damage and support sustainable crop production.

5. Conclusion & Recommendations:

Green-synthesized iron oxide nanoparticles (IONPs) effectively enhance salinity tolerance in jalapeño by promoting growth, improving biochemical attributes, and reducing oxidative stress damage. To confirm their broader applicability, field-based evaluations are essential to assess environmental safety, economic viability, and scalability for sustainable integration into commercial agricultural production systems.

Keywords: Salinity Stress, Jalapeño, Sustainable Crop Production, Abiotic Stress Tolerance, Nanotechnology in Agriculture.

Behavioral Intentions and Determinants of Consumer Preference for Islamic Banks in Faisalabad

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1. Introduction:

Islamic banking operates under the principles of Islamic Shariah, which prohibit interest (riba), promote ethical investments, and uphold social and economic justice. Over the past two decades, Islamic banking has expanded significantly across both Muslim-majority and non-Muslim countries. In Pakistan, it has emerged as a fast-growing segment of the financial industry, fueled by increasing customer interest and institutional support. However, many consumers continue to use both Islamic and conventional banking services, suggesting that factors beyond religious beliefs, such as awareness, satisfaction, and perceptions of compliance, shape banking preferences.

2. Objectives:

This study aims to identify the key determinants influencing consumer preferences for Islamic banking, with a particular focus on customer awareness, perceived Shariah compliance, satisfaction levels, and demographic variables.

3. Methodology:

A quantitative research design was adopted. Primary data were collected from 230 respondents in Faisalabad, including users of both Islamic and conventional banks. A structured questionnaire based on a five-point Likert scale was used. Data were analyzed using SPSS, applying binary logistic regression to assess the impact of various factors on consumer preference for Islamic banking (coded as 1) versus non-preference (coded as 0). Independent variables included consumer knowledge, perceived Shariah compliance, satisfaction, and demographic characteristics such as age, gender, education, marital status, income, and region.

4. Results:

The logistic regression model was statistically significant (Chi-square = 81.44, $p < 0.001$; $R^2 = 0.259$). Consumer knowledge had a strong, positive effect on preference for Islamic banking (OR = 2.617–4.234, $p < 0.01$), as did perceived Shariah compliance (OR = 1.905–3.544, $p < 0.05$). Satisfaction showed limited impact, with only one negative effect (OR = 0.345, $p = 0.005$). Among demographics, only education significantly influenced preference ($p = 0.009$), while age, income, marital status, gender, and religion were non-significant.

5. Conclusion & Recommendations:

The study concludes that consumer awareness and perceived Shariah compliance are the main drivers of Islamic banking preference, with education also influential. Customer satisfaction, unlike in conventional banking, has limited impact, emphasizing religious and ethical considerations. To support growth, the study recommends educational campaigns on Islamic finance, expanding Shariah-compliant products, strengthening Shariah governance, providing staff training, and aligning services with customer values and regulatory standards to build trust and long-term engagement.

Keywords: Behavioral Intentions, Consumer Preferences, Islamic Banking, Customer Satisfaction, Shariah Compliance, Ethical Finance

Gender Dynamics in Rice Cultivation: Implications for Women's Empowerment and Sustainable Agriculture in District Sialkot, Pakistan

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1. Introduction:

Agriculture is a cornerstone of Pakistan's economy, contributing 24% to national GDP and employing over 37% of the labor force. Rice, a key staple crop, supports food security and economic development, contributing 1.9% to agricultural value-added and 0.4% to overall GDP. Despite its importance, the gendered aspects of rice cultivation remain underexplored. Women actively participate in multiple production stages, planting, weeding, harvesting, and post-harvest processing, but frequently lack access to essential resources, training, financial support, and decision-making authority, limiting their recognition and empowerment within the agricultural value chain.

2. Objectives:

This study aims to explore gender dynamics in rice farming and assess the implications for women's empowerment and the sustainability of rice production in District Sialkot, Punjab.

3. Methodology:

A multistage sampling technique will be used. District Sialkot and its four tehsils (Daska, Pasrur, Sialkot, and Sambrial) will be selected. Four union councils will be chosen from each tehsil, and 10 male and 10 female rice farmers will be selected from each UC, resulting in 320 respondents (160 male and 160 female farmers). Additionally, 10 key informants (from public and private sector organizations) will be purposively selected to provide expert insights. Structured interviews will be conducted separately for men and women. Data will be analyzed using SPSS, and independent sample t-tests will compare gender-based differences in empowerment indicators and farming practices.

4. Results (Expected):

The study anticipates revealing significant disparities between male and female farmers in terms of decision-making authority, access to training, market participation, and resource ownership. It is expected that women contribute substantially to rice farming but face institutional and cultural constraints limiting their empowerment.

5. Conclusion & Recommendations (Expected):

Findings will inform gender-sensitive agricultural policies and interventions aimed at promoting equitable access to agricultural services and enhancing women's role in sustainable rice production. Recommendations will include capacity-building programs, inclusive extension services, and gender mainstreaming in rice value chains.

Keywords: Gender Dynamics, Women's Empowerment, Rice Cultivation, Sustainable Agriculture, Sialkot

An Assessment of Gender Differences in the Use of Social Media for Learning at the University Level

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1. Introduction:

Social media encompasses a wide range of digital platforms that enable interaction, communication, idea exchange, and access to educational content. Its increasing adoption among university students has prompted interest in understanding how these tools are used for learning, collaboration, and information sharing. Notably, researchers are examining potential gender-based differences in usage patterns, preferences, and engagement, exploring how male and female students may leverage social media differently to support their academic performance and knowledge acquisition.

2. Objectives:

The study aims to assess gender differences in the use of social media for learning among postgraduate students at the university level. Specifically, it explores frequency of use, preferred platforms, and extent of engagement with academic content across genders.

3. Methodology:

The research was conducted at the University of Agriculture, Faisalabad (UAF), targeting postgraduate students in the Faculty of Social Sciences. A total of 140 students (70 male and 70 female) were selected using a convenience sampling technique. Data were collected through a structured questionnaire and analyzed using SPSS. Descriptive statistics (frequencies, percentages, means, and standard deviations) were applied, and a t-test was conducted to examine gender-based differences.

4. Results:

Most respondents (55.7%) were between 25–30 years of age. Daily academic use of social media was reported by 77.1% of male and 65.7% of female students. A statistically significant difference was found in the extent of social media use between male and female students ($t = -1.924$, $p = 0.000$), indicating distinct usage patterns. Facebook was the most used platform for academic purposes (57.1%), although no significant gender difference was observed in platform preference.

5. Conclusion & Recommendations:

The findings suggest that gender plays a role in how students engage with social media for academic purposes, with male students using it more extensively. Educational institutions should design gender-inclusive digital literacy programs and promote responsible academic use of social media. Additionally, integrating social media into formal learning platforms could help bridge the gender gap and enhance academic outcomes for all students.

Keywords: Gender Differences, Social Media, Academic Learning, Digital Literacy, University Students

Financial Literacy and Financial Inclusion among Female Entrepreneurs: A Case Study of Faisalabad, Punjab

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1. Introduction:

Financial literacy enables individuals, especially entrepreneurs, to make informed financial decisions and achieve economic well-being. It is influenced by factors such as education, income, and occupation. In the digital era, digital financial literacy, encompassing the ability to use digital financial tools, has become crucial, particularly for women entrepreneurs who face barriers to accessing formal financial services. Despite its importance, financial literacy remains low globally, and Pakistan is no exception. Although Punjab has the highest literacy rate in the country, significant gender gaps in financial literacy and financial inclusion persist, warranting focused research and policy responses.

2. Objectives:

This study aimed to: estimate the level of financial literacy in Pakistan; analyze gender disparities in financial and digital financial literacy among entrepreneurs in Punjab; examine gender gaps in financial inclusion; and assess the impact of digital financial literacy on financial inclusion among female entrepreneurs.

3. Methodology:

To assess national financial literacy trends, secondary data from the World Bank's Global Findex database were analyzed. For Punjab-specific analysis, primary data were collected using a structured questionnaire. The sampling framework was based on Pakistan Social and Living Standards Measurement (PSLM) microdata (2019–20). Faisalabad district, which showed a relatively high concentration of female entrepreneurs, was selected for primary data collection. A sample of 237 entrepreneurs was surveyed, including 137 men (58%) and 100 women (42%).

4. Results:

Global Findex data indicated that only 21% of Pakistan's population has a bank account, with just 13% of women having access to formal banking highlighting a major gender gap. Pakistan ranks among the lowest for account ownership in lower-middle-income countries. Primary data analysis revealed statistically significant gender gaps in financial literacy, digital financial literacy, and financial inclusion in Punjab. Female entrepreneurs scored lower across all indicators compared to their male counterparts. Importantly, digital financial literacy was found to have a strong positive effect on financial inclusion for entrepreneurs.

5. Conclusion & Recommendations:

The study underscores the urgent need for gender-sensitive interventions aimed at enhancing both financial and digital financial literacy among female entrepreneurs. Policies that address these gaps can promote equitable access to financial services, thereby contributing to women's economic empowerment and broader financial inclusion in Punjab.

Keywords: Financial Literacy, Digital Financial Literacy, Financial Inclusion, Women Entrepreneurs, Punjab, Pakistan

Harnessing Policy and Institutional Innovations to Achieve the MDGs in Pakistan

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1. Introduction:

Global evidence shows that knowledge sharing, local experience, and policy innovation are central to achieving the Millennium Development Goals (MDGs). In Pakistan, despite a rich base of indigenous knowledge, widespread application of innovative solutions remains limited due to information asymmetry. This restricts the diffusion and scalability of locally developed ideas that could significantly contribute to socio-economic progress.

2. Objectives:

This study aims to explore how information gaps, lack of institutional support, and inadequate sharing networks hinder the replication and mainstreaming of indigenous innovations. Often, Pakistan imports external models that may be ill-suited to local realities, while homegrown solutions remain underutilized. The paper examines how a more structured and inclusive innovation-sharing framework can improve policy and institutional performance on MDG-related outcomes.

3. Methodology:

Using a qualitative review of secondary sources and documented case studies from across the region, this study analyzes emerging evidence on how policy and institutional innovations have facilitated MDG progress. A framework is used to evaluate innovations across three dimensions: policy (governance and strategy), process (operational and financial mechanisms), and product/service (impact on delivery and outcomes).

4. Results:

Findings suggest that MDG progress in Pakistan has been uneven, with education performing relatively well, health lagging behind, and poverty reduction showing moderate success. Innovations categorized under the “three Ps” Policy, Process, and Product have had varying levels of influence. Institutional gaps and lack of integration between local and national policy actors continue to limit the scale-up of successful interventions.

5. Conclusion & Recommendations:

To accelerate MDG achievement, Pakistan must prioritize institutional frameworks that promote innovation sharing, reduce information asymmetries, and support locally driven solutions. Emphasis should be placed on areas with low performance (health), consolidating gains in education, and accelerating poverty reduction through adaptive policy models. Strengthening knowledge networks, building local capacities, and incentivizing innovation diffusion are critical for long-term development transformation.

Keywords: Millennium Development Goals, Policy Innovation, Institutional Reform, Knowledge Sharing, Indigenous Innovation, Pakistan

Impact of Online Earning and Social Media Usage on the Academic Performance of University Students in South Punjab

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1. Introduction:

In the digital era, social media platforms and online income opportunities have become integral to student life. While social media supports academic learning and global connectivity, excessive use can distract students and reduce study time. Simultaneously, online earnings have emerged as a common means for students to manage educational and household expenses. However, part-time work and online engagements often compromise academic performance due to poor time management and divided attention.

2. Objectives:

This study aimed to examine the effects of social media usage and online earning on the academic performance of university students in South Punjab.

3. Methodology:

Primary data were collected using a structured questionnaire administered to a sample of 434 students from three universities: COMSATS University Islamabad (Vehari Campus), Education University Vehari Campus, and Bahauddin Zakariya University Multan. A systematic sampling technique was employed. The Multinomial Logit Model was used to assess how varying levels of social media use and online earning influence academic performance, while a Probit Model was applied to identify determinants influencing students' engagement in social media and online income-generating activities.

4. Results:

The findings revealed that both times spent on social media and participation in online earning activities significantly affect students' academic outcomes. Students engaged in extensive online earning or excessive social media usage reported lower academic performance. Mismanagement of time emerged as a major challenge, with many students struggling to balance academic responsibilities with digital work and social engagements.

5. Conclusion & Recommendations:

The study concludes that while digital platforms offer valuable educational and economic opportunities, they also present risks when not managed effectively. Universities and policymakers should initiate awareness programs and provide training on digital time management and responsible internet use. Promoting a balanced lifestyle can help students harness the benefits of digital tools without compromising academic achievement.

Keywords: Social Media, Online Earning, Academic Performance, Internet Use, University Students, South Punjab

Estimating the Economic Cost of Prolonged Khula Cases: Empirical Evidence from Vehari District

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1. Introduction:

A functional judicial system is vital for economic development, as it ensures contract enforcement and protection of individual rights. However, in Pakistan, lower courts are plagued by case backlogs and procedural delays that disproportionately affect women, particularly in matters of divorce, alimony, and inheritance. These judicial inefficiencies often lead to prolonged litigation, undermining women's ability to secure timely justice and compounding their economic and emotional distress.

2. Objectives:

This study investigates the underlying causes of judicial delays in Pakistan and their economic implications, with a specific focus on *khula* cases. It aims to quantify the direct and indirect costs of delayed proceedings and examine the socio-legal barriers women face while navigating the family court system.

3. Methodology:

Primary data were collected from litigants in family courts in Vehari District using a structured questionnaire. The instrument captured information on socio-economic background, case details, litigation duration, and the costs incurred, both financial and emotional. The study applies Cass R. Sunstein's concept of "sludge" to analyze how procedural burdens such as adjournments, inefficiencies, and bureaucratic red tape generate tangible economic and psychological costs for female litigants. These include court fees, transportation costs, opportunity costs, and mental health strain due to protracted proceedings.

4. Results:

Findings reveal that judicial inefficiencies, compounded by socioeconomic disparities, significantly burden women seeking *khula*. Delays in case resolution impose heavy financial expenses and psychological distress. Many women are forced to abandon or postpone legal proceedings due to the cumulative cost, both literal and emotional, of accessing justice. These delays not only prolong their legal and social uncertainty but also limit their economic participation and personal autonomy.

5. Conclusion & Recommendations:

The study underscores the urgent need for judicial reform focused on case management efficiency, the expansion of legal aid services, and the integration of psychosocial support mechanisms for female litigants. Streamlining judicial procedures and reducing legal "sludge" would facilitate faster resolution of family law cases and contribute to a more equitable justice system for women in Pakistan.

Keywords: Delayed Justice, *Khula* Cases, Women's Legal Rights, Economic Cost of Litigation, Judicial Reform, Pakistan

Innovation Subsidy Design and Payment for Ecosystem Services: A Mixed-Methods Approach to Multilateral Environmental Governance

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1. Introduction:

Unsustainable land use significantly contributes to climate change by increasing greenhouse gas emissions. Payments for Ecosystem Services (PES) provide financial incentives to promote sustainable natural resource management, linking ecological preservation with economic development. In Pakistan, escalating environmental challenges such as desertification, deforestation, and water scarcity highlight the need for PES, yet its adoption remains limited. Research is needed to design equitable, ecologically effective PES and subsidy schemes adapted to Pakistan's socio-political and ecological contexts, including transboundary resources like shared river basins.

2. Objectives:

This study seeks to: assess the ecological and behavioral outcomes of PES adoption; examine political and institutional factors influencing cross-border and cross-sector collaboration; and identify strategies to redesign agricultural subsidies to support long-term sustainability.

3. Methodology:

A mixed-methods design was used, integrating quantitative and qualitative approaches. Quantitative data came from household surveys, administrative PES datasets, and remote sensing, with 300–500 respondents selected via stratified purposive sampling across diverse ecological zones. Analyses included Difference-in-Differences regression and spatial econometrics. Qualitative data involved 45 semi-structured interviews with policymakers, NGO staff, and local leaders, plus three regional policy dialogues. Thematic analysis was conducted, and findings were triangulated with quantitative results to ensure robustness and validity.

4. Results:

Findings suggest that redesigned subsidies focusing on water-efficient crops and soil regeneration led to improved water use efficiency and increased farm-level incomes. PES initiatives showed moderate ecological improvements but high levels of community engagement and interest. However, institutional challenges such as poor coordination between federal and provincial agencies and a lack of legal frameworks for PES scaling were prominent. Stakeholders emphasized the importance of decentralized, community-driven models that align with local knowledge systems and cultural norms.

5. Conclusion & Recommendations:

This study demonstrates that context-sensitive PES approaches and innovative subsidy frameworks can improve environmental and socioeconomic outcomes in Pakistan. Effectiveness relies on inclusive governance, transparent benefit-sharing, and sustained local capacity-building. Findings provide a roadmap for scaling sustainable incentives under the Pakistan Climate Change Act and SDGs and offer insights for promoting transboundary environmental cooperation, particularly in shared ecosystems like the Indus River Basin.

Keywords: Payments for Ecosystem Services, Sustainable Land Use, Climate-Smart Subsidies, Environmental Governance, Climate Change, Pakistan

FinTech Innovation and Digital Banking Penetration: A Cross-Country Study of South and Southeast Asia

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1. Introduction:

Digital banking is revolutionizing financial ecosystems across the globe, particularly in emerging economies where financial technology (FinTech) offers scalable solutions for inclusion, efficiency, and transparency. In South and Southeast Asia, digital banking has become a critical driver of financial sector transformation, enabling access to financial services for underserved populations.

2. Objectives:

This study examines the comparative progress and challenges of digital banking adoption in Pakistan relative to peer economies India, Malaysia, and Bangladesh. It aims to assess policy effectiveness, technological infrastructure, and FinTech innovation capacity to identify actionable pathways for accelerated digital financial inclusion in Pakistan.

3. Methodology:

A mixed-methods approach was employed, combining secondary data analysis, regulatory reviews, and cross-country benchmarking. Key indicators evaluated include user adoption rates, internet and mobile penetration, regulatory frameworks (e.g., eKYC protocols), and investment flows into FinTech ecosystems.

4. Results:

Despite advances in branchless banking and mobile wallets, Pakistan lags behind regional peers. In 2023, digital banking users numbered approximately 24 million, or 10.5% of the population, compared to 290 million in India, 70 million in Bangladesh, and over 20 million in Malaysia. Penetration remains around 15%, limited by low internet access, legacy banking systems, and fragmented eKYC. Operational challenges include high cost-to-income ratios and limited FinTech investment, while behavioral barriers such as financial illiteracy, distrust, and cash reliance hinder adoption. Regional models like India's UPI, Malaysia's eKYC integration, and Bangladesh's mobile-first approach offer effective examples.

5. Conclusion & Recommendations:

To accelerate digital financial inclusion, Pakistan must strengthen eKYC regulations, expand rural broadband and mobile infrastructure, ensure interoperability between banks and FinTech platforms, invest in cybersecurity and data privacy, and promote nationwide digital literacy, especially among underserved populations. Strategic collaboration among the State Bank, telecom operators, FinTech startups, and development agencies is essential to transition from a cash-based system to a digitally inclusive, growth-oriented financial ecosystem.

Keywords: Digital Banking, FinTech Innovation, Financial Inclusion, South and Southeast Asia, eKYC, Pakistan

Impact of Defence Saving Certificates on Pakistan's GDP

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1. Introduction:

The National Savings Organization (NSO) has significantly contributed to Pakistan's economic development by mobilizing domestic savings through instruments like Defence Saving Certificates (DSCs). These low-risk, government-backed instruments provide secure investment options while supporting national fiscal requirements. Despite their longstanding presence, limited research has assessed their impact on macroeconomic indicators. This study fills that gap by examining the role of DSCs in Pakistan's economic performance, focusing on their comparative influence alongside other financial measures, including Gross Domestic Savings (GDS) and Gross Capital Formation (GCF).

2. Objectives:

The objectives of this study are to; evaluate the relationship between Defence Saving Certificates (DSCs) and Pakistan's GDP; determine whether DSCs have a statistically significant impact on economic growth; and compare the influence of DSCs with other macroeconomic variables like GDS and GCF.

3. Methodology:

This study employs a quantitative analytical framework using secondary time-series data from 1990 to 2024. Data sources include the State Bank of Pakistan, the World Bank, and official reports from the National Savings Organization. Econometric techniques, including multiple regression analysis and stationarity tests, are applied to assess the long-run and short-run relationships between DSCs and GDP. The model controls key financial indicators such as GDS and GCF to isolate the effect of DSCs.

4. Results:

Empirical results reveal a statistically significant and positive relationship between Defence Saving Certificates and GDP growth in Pakistan. The findings suggest that increased investment in DSCs correlates with higher levels of national output. Additionally, GDS and GCF also show positive associations with GDP, though the magnitude of DSCs' impact remains noteworthy. The results underscore the role of domestic savings schemes in strengthening macroeconomic stability and fiscal capacity.

5. Conclusion & Recommendations:

The study concludes that Defence Saving Certificates (DSCs) effectively promote economic growth in Pakistan. Enhancing their appeal and accessibility, especially for middle- and lower-income households, can boost domestic capital formation. Strengthening financial literacy, institutional trust, and technology integration in NSO operations may increase participation. Future research could examine behavioral factors and regional differences in DSC uptake and impact.

Keywords: Defence Saving Certificates (DSCs), Gross Domestic Product (GDP), Gross Domestic Savings (GDS), Gross Capital Formation (GCF), National Savings Organization

Effect of Divorce on Children's Health and Education in District Layyah

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1. Introduction:

Parental divorce has far-reaching consequences on children's development, especially in rural and socio-economically challenged regions. In District Layyah, a largely underdeveloped area in southern Punjab, Pakistan, limited access to healthcare, education, and social support networks amplifies the vulnerabilities of children from separated families. This study investigates how divorce affects the physical health, mental well-being, and educational outcomes of children in this context.

2. Objectives:

The objectives of the study are to; assess the impact of parental divorce on the physical and mental health of children; examine the relationship between divorce and educational performance, attendance, and social behavior among school-aged children; and identify socioeconomic and family-level factors that exacerbate or mitigate these impacts.

3. Methodology:

A multistage sampling strategy selected 120 divorced households with school-aged children, utilizing purposive and snowball sampling techniques. Data were collected via a structured, pre-tested questionnaire. Logistic regression and bivariate probit models were applied to examine the impact of parental divorce on children's health and education outcomes. Statistical analyses were conducted using SPSS and STATA to ensure robust and reliable results.

4. Results:

The study found that children of divorced parents exhibited significantly higher rates of malnutrition, recurring illness, and poor hygiene. Mental health concerns such as anxiety, emotional instability, and behavioral disorders were also prevalent. In terms of education, these children showed lower school attendance, reduced classroom engagement, and weaker academic performance. Teachers reported erratic behavior, concentration issues, and limited peer interaction among affected students. The negative outcomes were particularly pronounced in families with lower income, less educated mothers, and absence of extended family support.

5. Conclusion & Recommendations:

Parental divorce significantly negatively affects children's health and education in District Layyah, exacerbated by socio-economic deprivation and limited institutional support. The study recommends school-based counseling, targeted healthcare and nutritional programs, parental awareness initiatives, and financial assistance for vulnerable families. These findings underscore the urgent need for a responsive social protection framework in rural communities to mitigate the long-term impacts of family disintegration.

Keywords: Parental Divorce, Child Well-Being, Malnutrition, Academic Performance, Rural Pakistan, Socio-Economic Vulnerability

Climate-Induced Urbanization and the Dynamics of Urban Poverty: An Empirical Analysis

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1. Introduction:

Climate change is increasingly driving rural populations toward urban areas, causing rapid, unplanned urbanization. This migration strains urban infrastructure, escalating unemployment, deepening poverty, and degrading service delivery. Understanding the link between climate-induced urbanization and urban poverty is crucial for effective social protection and inclusive urban planning. This study empirically examines the relationship between climatic factors and urban poverty in Pakistan using time series data from 1990 to 2024.

2. Objectives:

To analyze the long- and short-run effects of climate-induced rural-to-urban migration on urban poverty levels in Pakistan and to propose policy recommendations for managing urbanization in a climate-resilient manner.

3. Methodology:

The study employed the Augmented Dickey-Fuller (ADF) test to confirm the stationarity of the data. Once stationarity was established, the Autoregressive Distributed Lag (ARDL) model was applied to determine long-run relationships, while the Error Correction Model (ECM) captured short-run dynamics. Model robustness and reliability were validated using the F-bound test, along with CUSUM and CUSUM-squared diagnostic tests.

4. Results:

The findings indicate that climatic variables, particularly rising temperatures and changing precipitation patterns, have a significant and positive long-term effect on urban poverty, implying that climate change contributes to worsening living conditions in urban areas. The ECM results further confirm that climate-induced urbanization is accelerating the growth of the poor urban population in the short run. Conversely, GDP per capita was found to have a statistically significant negative relationship with urban poverty, suggesting that higher economic growth can mitigate poverty to some extent.

5. Conclusion & Recommendations:

The study concludes that climate-induced migration significantly drives urban poverty in Pakistan. Addressing this requires investing in climate-smart agriculture and green infrastructure to enhance rural livelihoods and reduce migration pressures. Promoting agro-based industries, vocational training, and improving access to healthcare, education, and energy in rural areas are also essential. These integrated strategies can help balance rural-urban migration and foster equitable, sustainable urban development.

Keywords: Climate-induced Urbanization, Rural-urban Migration, Urban Poverty, ARDL, Climate Change, Pakistan

Motivational Factors and Opportunities for Entrepreneurial Development among Women: A Case Study of District Faisalabad

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1. Introduction:

Women entrepreneurship is vital for economic development and social progress in Pakistan, yet women face challenges such as limited resources, social constraints, and institutional barriers. This study explores motivational factors and opportunities shaping women entrepreneurs in District Faisalabad. Entrepreneurship helps women reduce economic dependency, tackle inequality, and combat unemployment, while improving household income, financial independence, decision-making power, and access to healthcare and education.

2. Objectives:

The objectives of this study are to: identify the key motivational factors driving women toward entrepreneurship; examine the socioeconomic opportunities available to women entrepreneurs in District Faisalabad; and analyze the impact of various socioeconomic factors on the income levels of women entrepreneurs.

3. Methodology:

Primary data were collected from 120 women entrepreneurs in District Faisalabad using a snowball sampling technique. A well-structured questionnaire was developed, comprising closed-ended questions measured on a five-point Likert scale. The data were analyzed using SPSS software. Descriptive statistics were used to summarize respondent characteristics, while a multiple linear regression model was applied to evaluate the impact of independent variables (socioeconomic factors) on the dependent variable (entrepreneurial income).

4. Results:

The results indicate that various socioeconomic factors, including education, access to credit, family support, and prior work experience, significantly influence both the likelihood of women engaging in entrepreneurship and their income levels. Motivation was primarily driven by the need for financial independence, desire for self-fulfillment, and the opportunity to support family income. The analysis also highlighted that institutional support and market access play a critical role in enabling women to sustain and grow their businesses.

5. Conclusion & Recommendations:

The study concludes that socioeconomic factors are key drivers in promoting women entrepreneurship in Faisalabad. Targeted policy interventions such as skill development programs, easier access to finance, mentorship opportunities, and women-friendly business regulations are recommended to enhance entrepreneurial outcomes. Encouraging women-led enterprises through inclusive policies can contribute significantly to economic empowerment and social equity.

Keywords: Women Entrepreneurship, Motivational Factors, Socioeconomic Opportunities, Entrepreneurial Income, Faisalabad

Factors Affecting the Adoption of Solar-Powered Irrigation Systems by Rice Growers in Hafizabad, Pakistan

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1. Introduction:

Rice is a key crop in Pakistan's agricultural economy, supporting exports and rural livelihoods but facing challenges due to water intensity and dependence on costly conventional energy. Solar-powered irrigation systems (SPIS) offer a sustainable alternative by improving water efficiency, lowering costs, and reducing environmental impacts. This study examines socioeconomic and institutional factors affecting SPIS adoption among rice farmers in Hafizabad District, Punjab.

2. Objectives:

The objectives of this study are to identify the key factors influencing the adoption of SPIS among rice growers; assess the constraints that limit the uptake of solar-powered technologies in irrigation; and provide policy recommendations for promoting renewable energy solutions in agriculture.

3. Methodology:

Primary data were collected through structured questionnaires from a sample of 102 rice growers, selected using stratified random sampling. Descriptive statistics, cross-tabulation, and binary logistic regression were employed to analyze the impact of various independent variables, including education, farm size, income, finance, and institutional support, on the likelihood of SPIS adoption.

4. Results:

The analysis revealed that farmers facing acute water shortages are significantly more inclined to adopt SPIS. Key positive determinants of adoption include higher education levels, larger farm holdings, and active participation in farmer associations. Conversely, the main barriers identified were high initial installation costs, lack of affordable financing options, limited technical knowledge, and weak extension services. Access to training and government-led awareness campaigns also played a role in shaping perceptions and decisions around adoption of SPIS.

5. Conclusion & Recommendations:

The study concludes that while SPIS offers a viable and environmentally sound irrigation alternative, its adoption is constrained by financial, informational, and institutional barriers. To scale up the adoption of SPIS among rice growers, the government and development partners should introduce targeted interventions such as interest-free loans, upfront subsidies, capacity-building programs, and robust extension services. Strengthening farmer cooperatives and public-private partnerships can further enhance access to technology and support services. These efforts are crucial for mainstreaming renewable energy in Pakistan's agriculture and ensuring long-term sustainability in the face of climate and resource challenges.

Keywords: Solar Energy, Renewable Irrigation, Adoption Barriers, Rice Farmers, Financial Constraints, Agricultural Innovation, Hafizabad, Pakistan

Moderating with Strategy: The Dormant Role of Monetary Policy in Debt Reduction of Pakistan

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1. Introduction:

This study examines the potential of monetary policy as an effective instrument for reducing Pakistan's growing public debt burden, drawing comparative insights from the experiences of other low-income countries. It focuses on the dynamic interaction between the debt-to-GDP ratio and major monetary policy tools, including the policy rate, inflation rate, and exchange rate. In addition, two critical macroeconomic indicators, fiscal deficit (as a percentage of GDP) and GDP growth, are analyzed over the period 1990–2024 to assess their combined impact on debt sustainability and economic stability.

2. Methodology:

The analysis applies the Autoregressive Distributed Lag (ARDL) bounds testing approach to investigate both short-run and long-run dynamics, selected due to the presence of mixed-order integration as confirmed by the Augmented Dickey-Fuller (ADF) test. To further ensure robustness, Granger causality tests were employed to establish causal linkages, while diagnostic tests, including CUSUM and CUSUMSQ, validated overall model stability and reliability of the estimated relationships.

3. Results:

The findings indicate that inflation, GDP growth, and fiscal deficit exert a significant negative association with Pakistan's debt-to-GDP ratio, underscoring their role in easing debt burdens. Among these, a well-managed and growth-oriented fiscal deficit proves particularly vital for sustainable debt management. Conversely, exchange rate depreciation and higher policy rates are shown to escalate debt levels, highlighting the risks of relying on such measures. Granger causality tests further confirm unidirectional causality from inflation, GDP, and fiscal deficit toward debt dynamics.

4. Conclusion & Recommendations:

The study concludes that ensuring Pakistan's public debt sustainability requires a carefully balanced policy mix that integrates both fiscal and monetary measures. Coordinated strategies emphasizing controlled inflation, disciplined fiscal spending, and pro-growth initiatives can help reduce debt vulnerabilities. Lessons from successful low-income countries reinforce the importance of adopting an integrated, evidence-based framework that aligns economic stabilization with growth objectives. Such a data-driven approach can strengthen resilience and support long-term debt management in Pakistan's evolving macroeconomic context.

Keywords: Monetary Policy, Debt Sustainability, ARDL Model, Fiscal-Monetary Interaction, Pakistan Economy

Implications of Parental Socioeconomic Status on Child Labor: A Case Study of District Faisalabad

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1. Introduction:

Childhood is a formative stage of life that significantly shapes individual potential and the future development of society. However, in many developing countries, economic hardship forces families to send their children into the labor market at an early age. This study investigates the impact of parental socioeconomic status on the prevalence of child labor in District Faisalabad, Pakistan. The research specifically explores the factors driving child labor, the working conditions faced by children, and the challenges they experience in their daily lives.

2. Objectives:

The objectives of this study are to: identify socioeconomic factors of parents that lead to child labor; examine the working conditions and problems faced by child laborers; and explore the relationship between household income, child health, and working hours.

3. Methodology:

Primary data were collected through a structured questionnaire from a sample of 150 working children under the age of 15, selected through random sampling. Data were analyzed using descriptive statistics and correlation analysis to determine the relationships between parental characteristics and child labor dynamics.

4. Results:

Findings indicate that poverty, large family size, low parental education, and illness within the household are key drivers of child labor. Children working in workshops, hotels, and transport hubs reported dissatisfaction with their low wages and poor working conditions. A positive correlation was found between household income and children's working hours, while a negative correlation was observed between child illness and hours worked. Alarmingly, a growing trend of smoking among child laborers was also identified. Despite these hardships, a majority of the children expressed a strong desire to pursue education, hindered only by their families' economic constraints.

5. Conclusion & Recommendations:

The study concludes that child labor in Faisalabad is primarily driven by economic necessity and exacerbated by a lack of education and awareness. Addressing child labor requires coordinated efforts from both governmental and non-governmental organizations. Public awareness campaigns, increased access to free or subsidized education, social safety nets, and vocational training programs for parents can serve as effective measures to curb the issue. Policies should focus on reducing poverty at the household level to ensure that children can enjoy their right to education and a safe, healthy childhood.

Keywords: Child Labor, Parental Education, Poverty, Socioeconomic Status, Faisalabad, Household Income

Institutional Dynamics and Financial Inclusion: A Study of Selected Asian Economies

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1. Introduction:

Institutional quality is a crucial driver of financial inclusion, yet its role remains underexplored in Asian economies. This study investigates how institutional and socioeconomic factors influence financial inclusion across China, India, Singapore, Indonesia, and Malaysia. Using Global Findex data (2012–2021), it analyzes government effectiveness, literacy, mobile penetration, GDP per capita, and banking access in shaping financial access, usage, and service quality.

2. Objectives:

The objectives of this study are to: investigate the impact of institutional quality on financial inclusion in selected Asian economies; assess the role of mobile technology, banking infrastructure, and socioeconomic variables in enhancing inclusive finance; and identify policy gaps and opportunities for institutional reform that could foster equitable financial participation.

3. Methodology:

The study uses panel data regression techniques, including the Autoregressive Distributed Lag (ARDL) model and fixed-effects estimation. These methods are applied to time-series data sourced from the World Bank's Global Findex and World Development Indicators (WDI). Institutional variables such as government effectiveness were derived from the Worldwide Governance Indicators. Financial inclusion is measured through indicators such as account ownership, mobile money usage, and access to formal credit.

4. Results:

The findings reveal that mobile penetration and GDP per capita have statistically significant positive effects on financial inclusion at the 5% significance level. Access to banking services also demonstrates a strong positive association. Interestingly, government effectiveness shows a negative and statistically significant relationship with financial inclusion in certain contexts, possibly due to bureaucratic inefficiencies or regulatory complexity that impede outreach. Literacy rates have a positive but not statistically significant impact across all countries.

5. Conclusion & Recommendations:

The study underscores the context-specific nature of institutional influence on financial inclusion. While mobile-based financial services and economic growth clearly promote inclusive finance, the negative association with government effectiveness suggests that complex or overly centralized governance structures may inhibit access in certain settings.

To enhance financial inclusion in Asian economies, the study recommends: Expanding digital infrastructure and mobile banking platforms, simplifying regulatory processes to improve institutional accessibility, and designing inclusive policies that align with local socioeconomic realities and leverage digital innovations.

Keywords: Financial Inclusion, Institutional Quality, Mobile Penetration, Governance, Asian Economies, ARDL, Public Policy, Inclusive Finance

The Role of Financial Literacy in Agricultural Credit Accessibility: Evidence from Smallholder Farmers in Punjab, Pakistan

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1. Introduction:

Agriculture remains a cornerstone of economic development, food security, and poverty alleviation in developing countries. In Pakistan, the sector contributes significantly to GDP and employment, with Punjab province serving as the primary agricultural hub, producing major crops such as wheat, rice, sugarcane, and cotton. Despite the availability of formal credit mechanisms, smallholder farmers, who dominate the agricultural landscape, often face barriers in accessing credit. These constraints are frequently linked to low financial literacy, lack of collateral, and limited trust in formal financial institutions. This study investigates the role of financial literacy in determining agricultural credit accessibility among smallholder farmers in Punjab.

2. Objectives:

The objectives of this study are to: assess the financial literacy levels of smallholder farmers; examine the relationship between financial literacy and access to agricultural credit; and identify other socio-economic factors influencing credit uptake.

3. Methodology:

Primary data were collected from 140 farmers in three agriculturally significant districts including Multan, Gujranwala, and Faisalabad, using stratified random sampling. A structured questionnaire assessed financial literacy, demographic characteristics, and credit accessibility. Data analysis involved descriptive statistics, cross-tabulation, Chi-square tests, and binary logistic regression using SPSS (Version 25.0).

4. Results:

The results revealed that financial literacy and formal education significantly enhance access to agricultural credit. Logistic regression indicated a positive and statistically significant effect of financial knowledge on credit uptake, while age showed a negative association. Variables such as land ownership, farming experience, and digital access did not exhibit significant influence. Chi-square tests supported strong associations between education, financial awareness, and formal credit usage.

5. Conclusion & Recommendations:

The study concludes that improving financial literacy is critical to enhancing credit accessibility for smallholder farmers in Punjab. Policymakers, financial institutions, and agricultural extension programs should prioritize financial education to empower rural farmers, reduce dependency on informal lending, and promote sustainable agricultural practices. Integrating financial training into rural development initiatives can foster economic resilience and contribute to inclusive growth in the agricultural sector.

Keywords: Financial Literacy, Agricultural Credit, Logistic Regression, Rural Finance, Smallholder Farmers, Punjab, Pakistan

Agriculture: An Occupation or a Lifestyle? Evidence from Punjab, Pakistan

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1. Introduction:

Agriculture, one of the oldest human activities, has evolved into a global industry. However, in Punjab, Pakistan, farming remains deeply embedded in the cultural and social fabric of rural communities. Many farmers in the region continue to practice conventional methods rooted in tradition, often resisting modern agricultural innovations such as mechanization and fertilizer use. A significant proportion of farmers are illiterate or lack formal training, and agricultural labor is typically performed by the farmer and their family, reflecting minimal division of labor or specialization. This study explores whether agriculture in Punjab is perceived merely as an occupation for income generation or as a lifestyle encompassing social norms, values, and daily practices.

2. Objectives:

The objectives of this study are to: explore the cultural and social dimensions of farming in Punjab; determine whether agriculture is perceived as a lifestyle or an economic occupation among local farmers; and assess how this perception influences their adoption of modern agricultural practices.

3. Methodology:

Primary data were collected from 250 farmers across various districts of Punjab through structured questionnaires and semi-structured interviews. A mixed-methods approach was adopted, utilizing descriptive statistics for quantitative analysis and thematic analysis for qualitative responses to understand the lifestyle components associated with farming.

4. Results:

The findings reveal that for 85% of the farmers surveyed, agriculture is more than an occupation, it is a way of life. Their decisions related to finance, health, nutrition, social interaction, and even belief systems are closely intertwined with their agricultural practices. The study highlights that this deep-rooted connection to farming as a lifestyle significantly shapes farmers' resistance to adopting modern farming technologies and methods.

5. Conclusion & Recommendations:

The study concludes that agriculture in Punjab remains deeply connected to farmers' cultural identity and traditional lifestyle. While this integration offers a strong community bond and continuity of heritage, it also presents challenges for agricultural modernization. Policymakers should consider this socio-cultural dimension when designing interventions. Community-based awareness campaigns and participatory extension services can play a pivotal role in gradually aligning traditional practices with modern farming approaches, ensuring both cultural respect and economic progress.

Keywords: Agriculture, Lifestyle, Conventional Farming, Cultural Practices, Farmer Decision-Making, Modernization

Determinants of Healthcare Service Choice Among Factory Workers in Faisalabad

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1. Introduction:

Health is a fundamental asset influencing productivity and well-being, especially among industrial workers involved in physically demanding jobs. These workers often face multiple health risks stemming from physical, chemical, and biological exposures in occupational settings. In Pakistan's industrial hub, Faisalabad, the choice between public and private healthcare services remains a critical decision for factory workers. This study investigates the key socioeconomic and structural factors influencing their healthcare preferences, particularly the inclination towards private healthcare despite the availability of subsidized public facilities.

2. Objectives:

The objectives of this study are to: assess the socioeconomic and health status of factory workers in Faisalabad; and identify the factors influencing the choice between public and private healthcare services.

3. Methodology:

Primary data were gathered from a sample of 150 factory workers in Faisalabad through a structured and pre-tested questionnaire. The study employed descriptive statistics to summarize demographic and socioeconomic characteristics, while binary logistic regression, executed in SPSS, was used to identify and quantify the key determinants influencing workers' preferences for healthcare services and facilities.

4. Results:

The binary logistic regression results demonstrated that higher income levels, better education, dissatisfaction with the quality of public healthcare services, and greater distance from government facilities significantly increase the probability of workers preferring private healthcare providers. In contrast, affordability challenges and closer proximity to public hospitals were strong determinants of continued reliance on government services. These findings highlight the dual role of socioeconomic factors and service accessibility in shaping healthcare preferences among factory workers.

5. Conclusion & Recommendations:

The study concludes that healthcare service utilization among factory workers is strongly influenced by socioeconomic characteristics and quality of services. Policy makers should focus on improving the quality of services in public healthcare facilities. Such reforms can enhance health equity and reduce the financial burden of high treatment cost in private healthcare services on low-income industrial laborers.

Keywords: Healthcare Access, Service Choice, Factory Workers, Socioeconomic Factors, Public vs. Private Healthcare, Faisalabad

Assessing the Effects of Digital Transformation on Banking Sector Performance: Empirical Evidence from Pakistan

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1. Introduction:

As global banking systems rapidly adopt digital transformation, Pakistan's commercial banks face notable challenges such as outdated infrastructure, uneven technology adoption, and regulatory bottlenecks. This study investigates the impact of digital transformation on the financial and operational performance of commercial banks in Pakistan from 2012 to 2023. A composite Digital Transformation Index (DTI) was developed, incorporating indicators such as digital channel usage, investment in emerging technologies, and service innovation.

2. Objectives:

The objectives of this research are to: construct a Digital Transformation Index (DTI) for Pakistani commercial banks; evaluate the impact of digital transformation on bank profitability (measured by ROA) and operational efficiency (measured by CIR); and assess the strategic implications of digital adoption in the banking sector.

3. Methodology:

The study uses panel data from 2012–2023 and applies Pooled OLS, Fixed Effects, and Random Effects models. The Hausman test was used for model selection. Heteroskedasticity and autocorrelation were addressed through cluster-robust and panel-corrected standard errors.

4. Results:

Digital transformation showed no significant impact on profitability under the Fixed Effects model. However, under panel-corrected standard errors, the relationship turned negative and statistically significant at the 1% level, indicating that early-stage digital adoption may reduce profitability due to high implementation costs. Conversely, the effect of digital transformation on operational efficiency (CIR) was positive and significant at the 5% level, suggesting long-term efficiency gains. The explanatory power of the models was strong, with R^2 values of 67.5% for ROA and 64.6% for CIR.

5. Conclusion & Recommendations:

The findings suggest that while digital transformation may not immediately boost profitability, it enhances operational efficiency over time. Digital initiatives should be viewed as long-term strategic investments rather than short-term profit drivers. Banks are advised to align digital strategies with efficiency goals, while regulatory authorities should facilitate tailored, scalable support for digital adoption. This approach is vital to strengthen the resilience, competitiveness, and sustainability of Pakistan's banking sector.

Keywords: Digital Transformation, Commercial Banks, Banking Performance, Return on Assets (ROA), Cost-to-Income Ratio (CIR), Panel Data Analysis, Pakistan

Assessing the Role of Cybersecurity in Enhancing Customer Trust and Satisfaction in Pakistan's Online Banking Sector

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1. Introduction:

The rapid expansion of digital banking in Pakistan has enhanced customer convenience but also raised significant concerns regarding cybersecurity. Despite increased institutional investment in encryption, fraud detection, and secure platforms, user adoption remains inconsistent. Incidents of cyber fraud limited public awareness, and a lack of trust in digital infrastructure contribute to user hesitancy. This study investigates how institutional cybersecurity practices and customer awareness influence trust, satisfaction, and retention in online banking, with perceived security and perceived reliability as mediating variables.

2. Objectives:

The objectives of this study are to: examine the impact of cybersecurity practices and user awareness on trust and satisfaction; evaluate the mediating role of perceived security and reliability in shaping customer outcomes; provide recommendations for enhancing digital banking adoption in Pakistan.

3. Methodology:

Grounded in Protection Motivation Theory and trust-based models, this study adopts a quantitative, cross-sectional design. Primary data were collected from 210 purposively selected online banking users across major Pakistani cities who had recent digital banking experience and basic cybersecurity knowledge. Analysis was conducted using descriptive statistics, correlation, regression, and mediation testing through Partial Least Squares Structural Equation Modeling (PLS-SEM).

4. Results:

The findings reveal that both institutional cybersecurity measures and user awareness significantly enhance perceived security and reliability, which in turn positively influence trust, satisfaction, and long-term usage intentions. Mediation analysis confirmed that perceived security and reliability are key pathways linking cybersecurity efforts to customer outcomes. Qualitative feedback also revealed persistent concerns over app vulnerabilities, lack of transparency, and weak communication on security protocols.

5. Conclusion & Recommendations:

Cybersecurity in online banking must extend beyond technical controls to include transparent communication, user education, and trust-building initiatives. The study underscores the need for banks and policymakers to adopt a dual strategy that addresses both infrastructural security and psychological factors to foster stronger customer relationships and support sustainable digital banking growth in Pakistan.

Keywords: Customer Trust, Customer Satisfaction, Online Banking, Perceived Security, Perceived Reliability

Identifying Constraints, Enablers, and Opportunities for Women's Entrepreneurship in the Chickpea Sector of Punjab, Pakistan

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1. Introduction:

Women's entrepreneurship in agriculture is central to rural development, food security, and inclusive growth. In Punjab, which produces over 80% of Pakistan's chickpeas, the value chain is underdeveloped and gender imbalanced. Women, nearly half of the labor force, face a 20–30% productivity gap due to limited access to resources and decision-making. Despite contributing 12–15 hours daily, their entrepreneurial roles remain constrained. This study examines constraints and opportunities in chickpea-based agribusinesses.

2. Objectives:

The objectives of this research are to: identify the socio-economic, cultural, and institutional barriers limiting women's entrepreneurial participation; examine the enablers that facilitate their involvement in chickpea-related enterprises; suggest targeted interventions and policy recommendations for enhancing women's roles in the chickpea value chain.

3. Methodology:

A quantitative research design was adopted. Data were collected from 200 women involved in chickpea production and processing in Bhakkar and Chakwal districts using a pre-tested structured questionnaire. A snowball sampling method was employed. Descriptive statistics were computed using SPSS, and Partial Least Squares Structural Equation Modeling (PLS-SEM) was used to test the conceptual framework and study hypotheses.

4. Results:

Findings reveal that access to productive resources, education, and decision-making autonomy significantly and positively influence women's entrepreneurial engagement in the chickpea sector ($p < 0.05$). In contrast, institutional inefficiencies and deep-rooted socio-cultural norms pose significant barriers to their active participation. Moreover, lack of market access, limited financial services, and inadequate training infrastructure were also cited as critical impediments.

5. Conclusion & Recommendations:

To promote gender equity and economic inclusion in the chickpea value chain, there is a pressing need for gender-sensitive policies, improved institutional support, and capacity-building initiatives tailored to women's needs. Enhancing access to credit, training, technology, and market linkages will be vital to unlocking the full potential of women entrepreneurs in the agricultural sector. These findings offer practical insights for policymakers, development agencies, and stakeholders aiming to foster inclusive agribusiness ecosystems in Pakistan.

Keywords: Women's Entrepreneurship, Chickpea Value Chain, Gender Constraints, Access to Resources, Institutional Support, PLS-SEM

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The Role of Women's Empowerment in Shaping Child Nutrition and Obesity Outcomes: A Global Review

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1. Introduction:

The intersection of women's empowerment and child nutrition, spanning undernutrition and obesity, has gained global importance in public health and development. This review synthesizes evidence from 30+ studies (2017–2025) across Africa, Asia, Latin America, and high-income countries. Findings consistently link empowerment—through education, decision-making power, autonomy, and social agency—to improved child outcomes. Empowered women enhance food security, dietary diversity, and feeding practices, while disempowerment, marked by low education or restricted mobility, correlates with stunting, wasting, and poor nutrition.

2. Objectives:

This study reviews global evidence on links between women's empowerment and child nutrition, identifies key economic, social, and educational dimensions influencing obesity and undernutrition, examines family-centered interventions shaping outcomes, and provides insights to inform gender-responsive nutrition and health policies.

3. Methodology

This thematic literature review synthesizes peer-reviewed studies published between 2017 and 2025. Searches in PubMed, Scopus, and JSTOR used keywords such as "women's empowerment," "child nutrition," "maternal autonomy," and "childhood obesity." Studies were chosen for rigor, diversity, and relevance to empowerment-health pathways. Findings were interpreted using frameworks including the Women's Empowerment in Agriculture Index (WEAI), the SWPER Index, and Household Bargaining Theory.

4. Results:

Across diverse contexts, women's empowerment was strongly linked to improved child nutrition outcomes. In high- and middle-income countries such as the U.S. and Indonesia, family-centered interventions including parental education, counseling, and lifestyle changes helped reduce childhood obesity. Yet, structural factors like poverty, cultural norms, urbanization, and weak health infrastructure moderated these effects. In urban Ethiopia, the coexistence of overweight mothers and undernourished children illustrated the complex "double burden" of malnutrition.

5. Conclusion & Recommendations:

This review highlights maternal empowerment as a critical determinant of child health and nutrition, yet empowerment alone is insufficient without enabling socio-economic and institutional support. Tackling both malnutrition and obesity requires multisectoral strategies, including gender-sensitive health programs, investment in maternal education, and integrating empowerment metrics into nutrition policies. Women must be prioritized as central agents of nutritional equity.

Keywords: Women's Empowerment, Child Nutrition, Childhood Obesity, Maternal Autonomy, Family Health Interventions, Gender Policy

The Potential for Poverty Alleviation in Indonesia's Coastal Areas through Islamic-Based Seaweed Development: Issues, Challenges, and Strategic Solutions

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1. Introduction:

Indonesia's coastal poverty persists despite marine wealth. Seaweed cultivation offers sustainable livelihoods. This study examines how integrating Islamic economic principles can advance poverty alleviation, ecological sustainability, and social justice through seaweed-based community development.

2. Objectives:

The objectives of this research are to: assess the potential of seaweed cultivation in alleviating poverty in Indonesia's coastal regions; analyze the relevance and application of Islamic principles in guiding seaweed-based economic development; and identify challenges and strategic pathways for integrating Islamic values into coastal resource management

3. Methodology:

This study adopts a qualitative design using secondary sources, including literature, policy documents from governmental and Islamic institutions, and regional case studies. Data from Southeast and East Indonesia were thematically analyzed within Islamic ethical frameworks.

4. Results:

Coastal communities face intertwined challenges: climate-sensitive livelihoods, income instability, and limited alternatives. Farmers struggle with inadequate credit, technology, and transparent markets, while middlemen dominance and environmental degradation reduce yields. Islamic financial tools (zakat, waqf, sharia microfinance) remain underutilized. Strategic solutions include integrating Islamic finance, halal-certified value chains, ethical governance, public partnerships, and religious education promoting sustainability.

5. Conclusion & Recommendations:

Islamic-based seaweed development offers a culturally rooted, economically viable pathway to alleviate poverty in Indonesia's coastal regions. Aligning with Islamic ethics, it promotes inclusiveness, sustainability, and resilience. Institutionalizing Islamic finance, strengthening market linkages, and fostering multi-sectoral partnerships can advance livelihoods, ethical governance, and a sustainable blue economy.

Keywords: Seaweed, Poverty Alleviation, Islamic Economics, Coastal Communities, Blue Economy, Indonesia

Structural and Functional Insights into the Healthy Human Gut Microbiome

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1. Introduction:

The human gut hosts a highly diverse and complex microbial community essential for maintaining physiological homeostasis, immune regulation, and metabolic functions. This microbiota comprises bacteria, archaea, viruses, and eukaryotes, and its composition is influenced by factors such as age, diet, genetics, and environmental exposures. Although extensive global research has been conducted on gut microbiome diversity and function, the microbiota of the Pakistani population remains largely unexplored. Given the distinct regional dietary patterns and cultural practices, understanding the gut microbiome in this context is vital for developing population-specific health strategies.

2. Objectives:

This study aimed to characterize both the **s**tructural (taxonomic) and functional profiles of the gut microbiota in healthy Pakistani individuals using whole-metagenome shotgun sequencing. By doing so, it seeks to fill a critical knowledge gap in microbiome research specific to South Asian populations.

3. Methodology:

Fecal samples were collected from healthy adult volunteers across different regions of Pakistan. DNA was extracted and subjected to high-throughput whole-metagenome sequencing. Bioinformatics analyses, including taxonomic classification (down to species level) and functional annotation, were performed using state-of-the-art culture-independent tools and databases such as MetaPhlAn and HUMAnN.

4. Results:

The healthy Pakistani donor gut microbiome revealed unique taxonomic signatures potentially including a higher abundance of specific anaerobic bacterial taxa shaped by local dietary staples such as lentils, spices, and fermented foods. Functionally, distinct metabolic pathways related to carbohydrate fermentation, vitamin synthesis, and immune modulation were present, differing significantly from Western microbiome profiles.

5. Conclusion & Recommendations:

This was the first comprehensive study to profile the metagenomic landscape of the healthy Pakistani gut microbiome. The findings advanced our understanding of microbiome-host interactions in this population and could guide the development of personalized nutrition, targeted probiotic therapies, and population-specific health interventions. Moreover, the study contributes valuable data to global microbiome repositories, fostering inclusive microbiome science and future comparative research.

Keywords: Gut Microbiome, Metagenomics, Functional Insights, Taxonomic Profiling, Pakistani Population

Estimating the Effect of Income, Wealth, and Social Media Use on Students' Happiness in Vehari District

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1. Introduction:

Happiness or subjective well-being plays a vital role in enhancing individual productivity and broader economic growth. Multiple factors influence happiness, with income and wealth recognized as key economic contributors. In recent years, social media usage has significantly increased in Pakistan, particularly among students. While social media platforms offer connectivity and entertainment, excessive use may contribute to addiction and impact mental well-being, thereby affecting happiness.

2. Objectives:

This study seeks to examine how income levels, household wealth, and patterns of social media usage collectively influence the happiness, overall life satisfaction, and psychological well-being of university students in Vehari District.

3. Methodology:

The research was conducted among students from three institutions: COMSATS University Islamabad (Vehari Campus), University of Education Vehari Campus, and Bahauddin Zakariya University Sub-Campus Vehari. A total of 360 students (120 from each institution) were selected using a structured questionnaire. A binary logit regression model was employed to analyze the impact of selected variables on students' subjective well-being.

4. Results:

The analysis revealed a significant negative association between social media usage and student happiness, suggesting that excessive screen time diminishes overall well-being. A similar negative relationship was observed between pocket money and happiness, indicating financial allowances alone do not guarantee life satisfaction. Conversely, both low- and high-income students reported statistically significant positive associations with life satisfaction, highlighting that determinants beyond income strongly shape perceived happiness.

5. Conclusion & Recommendations:

The study underscores the complex role of economic resources and digital behaviors in influencing students' happiness. It recommends targeted awareness campaigns and counseling services within educational institutions to encourage responsible social media use, foster resilience, and help students recognize the importance of non-material dimensions of well-being.

Keywords: Subjective Well-being, Life Satisfaction, Income, Wealth, Social Media Use, University Students

Sustainable Water and Nutrient Management in Soil

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1. Introduction:

Sustainable management of water and nutrients is critical for ensuring crop productivity, maintaining soil fertility, and reducing environmental degradation. Climate change intensifies challenges by altering water availability and nutrient cycles. Emerging innovations such as nanomaterials, AI-based decision-support tools, IoT-enabled irrigation, and biochar offer promising solutions to optimize input use and minimize losses. When combined with integrated nutrient management, hydroponics, aquaponics, and conservation agriculture, these approaches strengthen resilience, enhance soil health, and contribute to long-term food security and environmental sustainability.

2. Objectives:

The objectives of this study are to: explore sustainable practices and emerging technologies for water and nutrient management in agriculture; assess the impact of AI, nanomaterials, and integrated nutrient management on soil health and crop productivity; and highlight the relevance of adaptive strategies in the context of climate change and site-specific variability.

3. Methodology:

This study follows a comprehensive literature review methodology, synthesizing findings from peer-reviewed research articles, experimental field trials, and meta-analyses. Comparative analysis was conducted across multiple cropping systems and ecological zones, with a focus on water-nutrient dynamics, input-use efficiency, and emerging technology applications.

4. Results:

Evidence suggests that combining smart irrigation systems with optimized nutrient application significantly improves water-use efficiency and yield. Nanomaterials enhance nutrient absorption, while AI tools increase precision in input delivery. INM practices foster microbial health and long-term fertility. Controlled environments like DRAPS minimize nutrient imbalances and maximize output. Conservation practices reduce greenhouse gas emissions and increase carbon retention.

5. Conclusion & Recommendations:

A systems-based, site-specific approach is essential for achieving sustainable nutrient and water management. Blending traditional conservation methods with advanced tools such as AI and nanotechnology can optimize resource use, reduce environmental impacts, and ensure long-term food security. Future policy should promote interdisciplinary research and farmer-accessible innovations aligned with Sustainable Development Goals (SDGs).

Keywords: Water-Nutrient Management, Nanomaterials, Integrated Nutrient Management (INM), Climate Change, Decoupled Recirculating Aquaponics System (DRAPS), Artificial Intelligence, Conservation Agriculture

Macroeconomic Attention Index and Financial Market Volatility: Evidence from South Asian Economies

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1. Introduction:

In an era of information overload, investor attention has emerged as a vital behavioral factor influencing financial markets. Macroeconomic attention, public concern or interest in economic conditions, can signal shifts in expectations and thus impact asset prices. This study explores the dynamic relationship between macroeconomic attention, oil price volatility, and stock market returns in South Asian economies over the period 1994–2024.

2. Objectives:

This research investigates how the Macroeconomic Attention Index (MAI), derived from digital search data, influences oil price volatility and stock market returns. It also evaluates whether such an index provides robust predictive signals for economic and financial trends in South Asia.

3. Methodology:

The MAI was constructed using Google Trends data, following Fisher's (2022) methodology. Both Principal Component Analysis (PCA) and Generalized Dynamic Principal Component Analysis (GDPCA) were applied to extract latent attention factors. A Vector Autoregressive (VAR) model was employed to assess causal and dynamic relationships between MAI, oil prices, and stock market indicators. Robustness was validated by comparing Google Trends-derived MAI with conventional macroeconomic indicators.

4. Results:

The analysis reveals that MAI is a self-sustaining variable, influenced significantly by oil price fluctuations and stock market behavior. The VAR model confirms that spikes in macroeconomic attention preceded increased oil price volatility and affect short-term stock market returns. Cross-validation with secondary macroeconomic data supports the reliability of MAI as a meaningful indicator for financial market movements in South Asia.

5. Conclusion & Recommendations:

This study highlights the potential of integrating digital attention metrics into traditional macro-financial analysis. Policymakers and investors in South Asian economies should monitor digital macroeconomic attention indicators alongside inflation, exchange rates, and policy announcements for better forecasting and risk management. Future research could extend this model to agricultural commodity markets to assess the broader relevance of attention-based analytics in economic forecasting.

Keywords: Macroeconomic Attention Index, Oil Price Volatility, Stock Market Returns, Google Trends, PCA, VAR Model, South Asia

Smart Living in Transition: Behavioral Intentions and Adoption Barriers to Home Automation in Pakistan

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1. Introduction:

The global transition toward smart living technologies is reshaping household practices by enhancing convenience, energy efficiency, and security. However, in developing economies like Pakistan, widespread adoption faces obstacles, including infrastructural limitations, affordability constraints, and behavioral resistance. Investigating user intentions and adoption drivers is essential for fostering inclusive, equitable, and sustainable digital transformation across diverse socio-economic groups.

2. Objectives:

This study examines the behavioral intention to adopt smart home technologies in Pakistan, an emerging market experiencing rapid digitalization. Despite growing interest, the adoption of such technologies remains underexplored, highlighting significant research and policy relevance.

3. Methodology:

Adopting the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) framework, this study conducted a cross-sectional survey of 732 respondents. Principal Component Analysis (PCA) was employed to derive composite indices, and heteroskedasticity-robust Ordinary Least Squares (OLS) regression was applied to identify key behavioral, social, and contextual predictors of smart home technology adoption.

4. Results:

The findings indicate that performance expectancy, social influence, facilitating conditions, hedonic motivation, price value, and habit are strong determinants of adoption intention for smart home technologies. Interestingly, effort expectancy proved statistically insignificant, suggesting usability is not a major barrier in Pakistan, diverging from global evidence. Demographic analysis shows higher adoption intent among youth (16–25 years), with income and smart device ownership marginally significant. Gender, geographic region, and rural–urban location exhibited no meaningful effects.

5. Conclusion & Recommendations:

These results question the universal applicability of established technology acceptance models, emphasizing the importance of tailoring frameworks to local realities in emerging markets. The study provides actionable guidance for policymakers, developers, and marketers seeking to expand smart home adoption beyond affluent urban segments, promoting inclusive digital transformation and equitable technological access.

Keywords: Smart Home Adoption, UTAUT2, Behavioral Intention, Technology Acceptance, Pakistan, Principal Component Analysis

Bridging Complexity and Practice: The Case for Agent-Based Modeling in Agricultural Policy and Resource Management in Pakistan

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1. Introduction:

Pakistan's agriculture faces climate stress, resource depletion, and fragmented supply chains, while traditional planning tools fail to capture system complexity. Agent-Based Modeling (ABM) simulates farmer–market–institution interactions, offering insights on feedback, adaptation, and uncertainty. Despite global use, ABM remains underutilized in Pakistan's policy design.

2. Objectives:

The study aims to: demonstrate the potential of Agent-Based Modeling in addressing complex agricultural and environmental challenges in Pakistan; propose a conceptual ABM framework for simulating smallholder decision-making under climate and market uncertainties; identify potential applications of ABM in irrigation policy, subsidy reform, technology adoption, and food security analysis; and encourage interdisciplinary collaboration and capacity-building for ABM in agricultural research.

3. Methodology:

This is a conceptual and methodological paper drawing upon interdisciplinary literature from agricultural economics, systems modeling, behavioral science, and computational simulation. The proposed framework outlines the core components of an agricultural ABM: agent typologies (e.g., risk-averse vs. innovative farmers), environment (climate shocks, market prices), institutional settings (subsidies, information access), and decision rules. Illustrative case applications and international examples are reviewed to support model feasibility.

4. Results (Expected/Conceptual):

Preliminary insights suggest that ABM can uncover non-linear policy outcomes, heterogeneous adoption rates of technologies, and unintended system-wide feedbacks, insights often missed by conventional models. Potential scenarios include differentiated impacts of irrigation policies across farm sizes, or how market shocks cascade through local food systems via agent interactions. The framework illustrates how ABM can guide more responsive, inclusive, and data-driven policy design.

5. Conclusion & Recommendations:

ABM represents a promising tool to enhance evidence-based policymaking and adaptive resource management in Pakistan's agriculture. To unlock its full potential, the study recommends (i) building interdisciplinary research teams, (ii) investing in training programs for simulation modeling, and (iii) developing open-access ABM platforms tailored to local agri-ecological and socio-economic contexts. Embracing complexity-based methods like ABM will strengthen Pakistan's capacity to build climate resilience, promote equity, and achieve sustainable development goals.

Keywords: Agent-Based Modeling, Complex Systems, Agricultural Policy, Interdisciplinary Methods, Climate Resilience

A Multidimensional Poverty Analysis: The Case of Urban and Peri-Urban Areas of Faisalabad, Pakistan

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1. Introduction:

Traditional poverty assessments in Pakistan have primarily relied on income-based indicators such as household earnings, consumption, and expenditures. However, such monetary metrics often fail to capture the broader, non-financial dimensions of poverty that reflect household well-being and deprivation. Recent advancements in poverty literature advocate for a multidimensional approach, which accounts for various aspects of living standards beyond mere financial capacity. This study applies the multidimensional poverty index (MPI) framework to assess the extent and determinants of poverty in the urban and peri-urban areas of Faisalabad, Pakistan.

2. Objectives:

The study aims to: measure the incidence of multidimensional poverty in urban and peri-urban areas of Faisalabad; and identify key socio-economic factors influencing multidimensional poverty in these regions.

3. Methodology:

Primary data were collected from 160 households using a stratified random sampling technique to ensure balanced representation from both urban and peri-urban zones. A Poisson regression model was employed to identify significant determinants of multidimensional poverty. The multidimensional index included indicators such as education, housing conditions, access to clean drinking water, income levels, and asset ownership.

4. Results:

Findings revealed that 68% of households in peri-urban areas were classified as multidimensionally poor, compared to 39% in urban areas. Key factors that significantly reduced poverty levels included higher education, household income, and ownership of rural assets. In contrast, larger family size, low educational attainment, inadequate housing, lack of access to clean drinking water, and absence of urban assets were positively associated with higher poverty scores.

5. Conclusion & Recommendations:

This study confirms that poverty in Faisalabad's peri-urban and urban regions is multidimensional in nature, extending beyond income deprivation. To effectively combat poverty, policy measures must focus on improving education, housing infrastructure, and access to clean water, while facilitating asset ownership among low-income households. Additionally, targeted interventions are needed in peri-urban areas where poverty levels are markedly higher. Integrating multidimensional indicators into national poverty assessments can lead to more comprehensive and equitable policy responses.

Keywords: Multidimensional Poverty, Marginality, Poisson Regression, Living Standards, Peri-Urban Areas, Pakistan

Comparative Study of Foliar and Basal NPK Application on Wheat Crop

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1. Introduction:

Agriculture supports nearly 70% of Pakistan's population, yet soil degradation, nutrient depletion, and poor fertilizer practices constrain wheat productivity. This study evaluates basal, foliar, and combined NPK applications to assess their effects on wheat growth, physiology, yield, nutrient uptake, and economic returns under local conditions.

2. Objectives:

To determine the most effective method and timing of NPK fertilizer application (basal, foliar, or combined) for improving wheat productivity, nutrient uptake, and profitability.

3. Methodology:

A field experiment was conducted using a randomized complete block design (RCBD) with four treatments: T0 (control; basal application only), T1 (basal + foliar at tillering, spiking, and milking), T2 (foliar only at tillering, spiking, and milking), and T3 (foliar at tillering and milking). Basal fertilizers were applied at recommended rates, while foliar applications were tailored to crop growth stages. Each treatment was replicated three times. Growth, physiological, yield-related traits, and nutrient concentrations (N, P, K) were measured, along with an economic cost–benefit analysis.

4. Results:

The combined basal + foliar application (T1) outperformed other treatments, with plant height (52.5 cm), dry matter (155.5 g), and relative water content (65%) significantly higher than the control. Grain yield rose 142% (25.5 g vs. 10.6 g). Nutrient concentrations (N, P, K) were maximized under T1, which also delivered the highest economic returns (USD 102; BCR 1.34).

5. Conclusion & Recommendations:

The study demonstrates that integrating basal and foliar NPK application at critical wheat growth stages significantly improves growth, physiology, yield, nutrient uptake, and profitability compared to basal application alone. Foliar feeding complements basal fertilization by addressing mid-season nutrient demands and mitigating soil nutrient limitations. Farmers should adopt a combined strategy to maximize wheat productivity and profitability, while policymakers should promote integrated nutrient management for sustainable food security.

Keywords: Wheat Productivity, Foliar Fertilization, Basal Fertilization, NPK Management, Benefit-Cost Ratio (BCR)

Digitalization and Employment in South Asia: A Panel Data Analysis of ICT-Driven Growth

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1. Introduction:

This study explores the relationship between digitalization and employment in South Asian countries, addressing a critical gap in understanding how digital technologies impact labor markets in developing economies. As the region undergoes rapid digital transformation, it becomes essential to assess how information and communication technologies (ICTs) influence job creation and employment structures.

2. Objectives:

The objectives of this study are to: construct a composite digitalization index for South Asian countries using ICT indicators; empirically analyze the impact of digitalization on employment using panel data; and identify key economic and policy-related variables influencing labor market outcomes in the digital age.

3. Methodology:

The study utilizes annual panel data from 2000 to 2022 for selected South Asian countries, sourced from the World Bank and International Labour Organization databases. A digitalization index was developed using Principal Component Analysis (PCA), incorporating four key ICT indicators: mobile cellular subscriptions, fixed broadband subscriptions, fixed telephone subscriptions, and internet usage. The Prais-Winsten regression model, corrected for autocorrelation, was employed after conducting a Hausman test to select between fixed and random effects. Control variables included GDP growth, education level, interest rates, and inflation.

4. Results:

The regression results indicate a statistically significant positive relationship between digitalization and employment (coefficient = 0.8656, $p < 0.001$), suggesting that increased ICT penetration drives job creation. Education also had a positive and significant effect on employment, reinforcing the role of human capital in digital labor markets. However, GDP growth, interest rate, and inflation did not exhibit statistically significant direct impacts on employment in the model.

5. Conclusion & Recommendations:

The findings underscore digitalization as a key enabler of employment growth in South Asia. Policymakers should therefore prioritize investments in digital infrastructure and foster digital skills training, particularly for youth and underserved communities. A focus on inclusive digital transformation will help mitigate risks of inequality and job displacement. Future research could explore sector-specific impacts and potential gender-differentiated outcomes of digital growth in labor markets.

Keywords: Digitalization, Employment, ICT, South Asia, Panel Data, Principal Component Analysis (PCA), Labor Markets

Biological Evaluation of *Citrus sinensis* Peel Essential Oil

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1. Introduction:

Phytochemicals derived from plants are abundant in bioactive compounds that exhibit antimicrobial, antioxidant, antifungal, and anti-inflammatory activities, making them valuable for food, pharmaceutical, and cosmetic applications. Citrus fruits, particularly *Citrus sinensis* (sweet orange), are an important source of essential oils rich in limonene and other active constituents, offering significant therapeutic potential while also serving diverse industrial roles in flavoring, preservation, and natural health-promoting formulations.

2. Objectives:

This study aimed to extract essential oil from the peels of *Citrus sinensis* and evaluate its biological activity, including antioxidant, antibacterial, and hemolytic effects.

3. Methodology:

Fresh *Citrus sinensis* peels were procured from a local market, carefully cleaned, and subjected to hydro distillation for essential oil extraction. The resulting oil was analyzed through Gas Chromatography–Mass Spectrometry (GC-MS) to determine its chemical composition. Biological activities, including antibacterial, hemolytic, and antioxidant potential, were systematically evaluated using standardized and previously validated protocols.

4. Results:

The essential oil yield was recorded at 0.44% (w/v), with minor variations influenced by factors such as extraction technique, climatic conditions, geographical origin, and soil characteristics. Gas Chromatography–Mass Spectrometry (GC-MS) analysis revealed a diverse profile of bioactive constituents. Functionally, the oil demonstrated strong antibacterial activity, moderate antioxidant capacity, and minimal hemolytic effects, highlighting its promising safety profile and potential application as an effective bioactive and therapeutic agent.

5. Conclusion & Recommendations:

The findings suggest that essential oil extracted from *Citrus sinensis* peels exhibits significant bioactive properties, positioning it as a safe, natural alternative for applications in food preservation, pharmaceutical formulations, and cosmetic industries. Its antibacterial and antioxidant potential supports multifunctional utility, while low hemolytic activity underscores safety. Further in-depth research is recommended to optimize formulations, evaluate long-term stability, and validate efficacy under real-world industrial and clinical conditions.

Keywords: *Citrus Sinensis*, Essential Oil, GC-MS, Peel Waste, Bioactives, Antioxidant, Antibacterial

Role of Decent Work in Female Labor Force Participation in the Private Sector of Punjab

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1. Introduction:

Traditionally, men have been the primary financial decision-makers in Pakistani households. However, evolving socio-economic dynamics have gradually increased women's involvement in financial and labor market activities, though their overall labor force participation remains low. The concept of "decent work," as promoted by the International Labour Organization (ILO), is considered critical to supporting and enhancing female labor market engagement. This study investigates the role of decent work conditions in shaping female labor force participation within the private sector in Punjab, Pakistan.

2. Objectives:

The objectives of this study are to: examine how various indicators of decent work influence women's participation in the labor force; and identify key socio-demographic and workplace factors affecting female employment in the private sector.

3. Methodology:

The study is based on primary data collected from 150 female respondents employed in the private sector in Punjab. A structured questionnaire was used to gather information on workplace conditions and socio-demographic factors. Descriptive statistics were used for initial analysis, followed by binary logistic regression to identify significant predictors of female labor force participation.

4. Results:

The results show that family type, the gender of the household head, and the number of working family members positively influence women's labor force participation. Among the decent work indicators, safe working conditions, sufficient rest and free time, and recognition and respect in the workplace were positively associated with continued employment. Conversely, job insecurity and workplace health risks were negatively associated with female participation. These findings highlight the importance of a supportive and secure working environment in encouraging women to join and remain in the workforce.

5. Conclusion & Recommendations:

The study concludes that decent work significantly contributes to enhancing female labor force participation in Punjab's private sector. Policies that ensure safe, respectful, and secure working conditions are essential to promoting gender-inclusive economic growth. Policymakers should prioritize the implementation of labor standards that align with the ILO's decent work agenda, with specific focus on gender equity and workplace safety, to facilitate higher and sustained participation of women in the labor market.

Keywords: Labor Force Participation, Decent Work, Female Employment, Private Sector, Gender Equity, Punjab

The Role of Psychological Resilience in Relation to Eco-Anxiety and Procreation Anxiety in Young Adults

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1. Introduction:

Escalating ecological degradation has contributed to growing psychological distress among young adults, often manifesting as eco-anxiety and reproductive hesitation. This study investigates the relationship between eco-anxiety and procreation anxiety in young adults aged 18–24, while examining the potential mediating role of psychological resilience. Grounded in Future Anxiety Theory and Cognitive Appraisal Theory, the research adopts an interdisciplinary lens to explore how environmental concerns influence critical life decisions.

2. Objectives:

To examine the correlation between eco-anxiety and procreation anxiety in young adults, and to assess whether psychological resilience mediates this relationship.

3. Methodology:

A quantitative, cross-sectional research design was employed to explore the relationships among eco-anxiety, resilience, and reproductive concerns related to climate change. A sample of 385 young adults was recruited from both public and private higher education institutions in Lahore. Participants completed three validated instruments: the Hogg Eco-Anxiety Scale (HEAS-13), the Connor-Davidson Resilience Scale (CD-RISC-10), and the Climate Change Related Reproductive Concerns Scale (CCRCS). Data analysis involved correlational analysis, hierarchical regression, and mediation analysis using the PROCESS Macro in SPSS. In addition to psychological variables, demographic factors such as gender and socioeconomic status were also examined to better understand their influence on the studied outcomes.

4. Results:

Findings revealed a significant positive correlation between all subscales of eco-anxiety and procreation anxiety. However, psychological resilience showed no significant association with either eco-anxiety or procreation anxiety and did not mediate the relationship between the two. Gender and socioeconomic differences were explored but did not yield strong moderating effects. These results challenge assumptions about resilience as a buffer against climate-related anxieties.

5. Conclusion & Recommendations:

This study highlights the emotional burden of climate change on youth, particularly in relation to reproductive decision-making. While eco-anxiety strongly predicts procreation anxiety, psychological resilience may not serve as a protective factor in this context. These findings underscore the need for culturally relevant mental health interventions and further interdisciplinary research to address the emotional dimensions of climate change in vulnerable populations. Policymakers and educators should consider integrating climate-related emotional education and support systems in youth-focused programs.

Keywords: Eco-anxiety, Procreation Anxiety, Psychological Resilience, Young Adults, Climate Psychology

Association of Electronic Media Engagement and Dietary Choices in Adults Aged 20 to 30 Years

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1. Introduction:

With the rapid advancement of industrialization and technology, electronic media, including internet-based platforms, radio, and television, has become widely accessible. Electronic media acts as a double-edged sword, influencing dietary patterns and physical activity in both positive and negative ways. This study investigates the relationship between electronic media usage and dietary behaviors among young adults aged 20 to 30 years.

2. Objectives:

The objectives of this study are to: analyze the duration and nature of electronic media use among young adults; and examine how electronic media influences dietary choices, physical activity, and anthropometric indicators such as BMI and waist-to-hip ratio.

3. Methodology:

A mixed-methods approach was employed, including a digital survey and face-to-face interviews. A total of 400 participants aged 20–30 years were randomly selected across Punjab. From this group, 200 participants from Faisalabad were selected using convenience sampling for anthropometric assessments. Data were collected via a structured questionnaire comprising sections on sociodemographic information, anthropometric measurements, dietary patterns, and physical activity levels. Chi-square tests were used for statistical analysis.

4. Results:

Findings showed a statistically significant association between electronic media usage and waist-to-hip ratio ($p = 0.002$) and BMI ($p = 0.009$). Among females, 76% reported that their dietary patterns were influenced by electronic media. Audiovisual content on food had a strong impact on food choices, with a significant association ($p = 0.006$). Additionally, behavior change campaigns via media showed a notable effect ($p = 0.019$). A significant relationship was also observed between media advertisements and consumer choices, such as the type of milk purchased ($p = 0.005$).

5. Conclusion & Recommendations:

The study highlights the profound influence of electronic media on young adults' dietary choices and body composition. There is an urgent need for the ethical regulation of food- and nutrition-related content on electronic media. Policies should be formulated to promote accurate, health-promoting messages and to mitigate the negative impact of misleading advertisements.

Keywords: Dietary Habits, Electronic Media, Social Media, Youth, Behavior Change, Anthropometry

Bioactivity Evaluation of Mentha Arvensis Essential Oil

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1. Introduction:

*Mentha arvensis (*family: *Lamiaceae)* is a perennial, aromatic herb traditionally valued for its diverse therapeutic properties, including digestive, analgesic, and antimicrobial uses. In recent years, the plant has gained increasing scientific attention due to its essential oil (EO), which contains a rich profile of bioactive compounds with promising medicinal applications in pharmaceuticals, nutraceuticals, and natural health products.

2. Objectives:

This study aimed to evaluate the chemical composition, antioxidant potential, and antibacterial activity of *Mentha arvensis* essential oil.

3. Methodology:

Essential oil was extracted from the aerial parts of *Mentha arvensis* using hydro-distillation. The chemical constituents of the oil were analyzed via Gas Chromatography–Mass Spectrometry (GC-MS). Antibacterial activity was tested against *Staphylococcus aureus* and *Escherichia coli* using the agar well diffusion method. Antioxidant activity was assessed using the DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging assay.

4. Results:

GC-MS analysis revealed the presence of 21 distinct chemical constituents in the essential oil of *Mentha arvensis*, with menthol and menthone emerging as the predominant compounds contributing to its characteristic aroma and bioactivity. The essential oil exhibited pronounced antibacterial activity, effectively inhibiting the growth of both *Staphylococcus aureus* and *Escherichia coli*. Additionally, it demonstrated substantial antioxidant potential, confirmed through its DPPH radical scavenging ability, suggesting its suitability as a natural bioactive agent for therapeutic and industrial applications.

5. Conclusion & Recommendations:

The findings suggest that *Mentha arvensis* essential oil possesses promising antibacterial and antioxidant properties. Its bioactive constituents, particularly menthol and menthone, indicate potential for development as a natural therapeutic agent. Further in vivo and toxicological studies are recommended to explore its efficacy and safety for pharmaceutical or nutraceutical applications.

Keywords: *Mentha Arvensis*, Essential Oil, GC-MS, Menthol, Antibacterial Activity, Antioxidant Activity

Impact of Demographic Variables on Economic Growth in South Asian Countries: A Panel Data Analysis

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1. Introduction:

Demographic variables such as fertility and mortality rates are key determinants of economic growth. In South Asia, ongoing demographic transitions, marked by declining fertility, increasing life expectancy, and a growing working-age population, offer a potential demographic dividend. This shift may accelerate economic development through increased labor supply, enhanced productivity, and higher savings rates. However, in the absence of appropriate policy interventions, it may also lead to a demographic burden or "debt." Despite South Asia's significant demographic shifts in recent decades, empirical studies evaluating their precise impact on long-term economic growth remain limited. This study addresses this gap by exploring the long-run relationship between demographic factors and GDP growth in Bangladesh, India, Pakistan, and Sri Lanka.

2. Objectives:

The objectives of this study are to: assess the long-run impact of demographic variables, specifically total fertility rate and life expectancy, on economic growth in South Asian countries; and quantify the effect of demographic changes on GDP per capita and inform policy planning.

3. Methodology:

Using a balanced panel dataset from 1976 to 2017, the study applies panel unit root tests (Levin–Lin & Chu, Im–Pesaran & Shin, ADF-Fisher, PP-Fisher) to assess stationarity. Long-run relationships are evaluated through Pedroni and Kao panel cointegration tests. Fully Modified Ordinary Least Squares (FMOLS) is then used to estimate the impact of demographic variables on GDP growth.

4. Results:

The analysis finds statistically significant relationships: a one-unit increase in the total fertility rate is associated with a 0.106-unit decrease in GDP per capita growth; conversely, a one-year increase in life expectancy corresponds to a 0.196-unit increase in GDP growth. These findings indicate that higher fertility suppresses, while greater longevity enhances long-term economic performance in the region.

5. Conclusion & Recommendations:

The study concludes that demographic dynamics play a critical role in shaping South Asian economic trajectories. Lower fertility and higher life expectancy contribute positively to sustained economic growth. The findings support the case for regional investment in health systems, reproductive health services, and education as part of comprehensive development strategies. Policymakers must prioritize demographic planning to harness the full potential of the demographic dividend and foster inclusive growth.

Keywords: Life Expectancy, Fertility Rate, Economic Growth, Panel Data, South Asia

Detection and Quantification of Antibiotic Residues in Broiler Meat from Rural Areas of Faisalabad, Pakistan

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1. Introduction:

The intensive use of antibiotics in poultry production, particularly in low- and middle-income countries, has provided economic and therapeutic advantages such as improved growth rates and disease control. However, indiscriminate or unregulated antibiotic administration can lead to the presence of residual antibiotics in poultry products, posing significant public health risks and contributing to the global crisis of antimicrobial resistance (AMR).

2. Objectives:

This study aimed to detect and quantify antibiotic residues in broiler meat (muscle and liver) collected from rural poultry farms in Faisalabad, Pakistan. The focus was on two antibiotic classes commonly used in poultry: amphenicols (florfenicol) and fluoroquinolones (enrofloxacin).

3. Methodology:

A total of 200 broiler samples (muscle and liver) were collected from rural markets and farms. Following a structured survey of antibiotic usage practices, ultra-high-performance liquid chromatography (UHPLC) with UV-visible detection was employed to analyze the samples. Residue concentrations were compared against international Maximum Residue Limits (MRLs).

4. Results:

The findings revealed a significant and widespread presence of antibiotic residues in broiler meat samples, raising concerns about food safety. Out of 200 samples analyzed, 60% (120 samples) tested positive for antibiotic residues. Liver tissues showed the highest contamination rate at 63%, followed by thigh muscle samples at 57%. In muscle tissues, the concentration of florfenicol residues ranged from 34 to 141 µg/kg, while enrofloxacin levels varied between 11 and 148 µg/kg. Liver tissues, however, exhibited much higher concentrations, with florfenicol ranging from 1,234 to 3,362 µg/kg and enrofloxacin from 25 to 296 µg/kg. These values indicate a substantial accumulation of antibiotics in liver tissues. Notably, the liver samples consistently exceeded the maximum residue limits (MRLs) set for both florfenicol and enrofloxacin, highlighting the potential health risks associated with the consumption of such contaminated meat.

5. Conclusion & Recommendations:

The study highlights urgent regulatory needs in Pakistan's poultry industry to curb antibiotic residue-related health risks. Recommended measures include enforcing withdrawal periods, implementing routine monitoring, promoting responsible veterinary antibiotic use, enhancing AMR surveillance, and educating farmers, thereby supporting antimicrobial stewardship and fostering safer, sustainable poultry production systems.

Keywords: Antibiotic Residues, Poultry Meat, Ultra-High-Performance Liquid Chromatography, Florfenicol, Enrofloxacin, Antimicrobial Resistance, Maximum Residue Limits, Pakistan

A Novel Strategy for Wastewater Purification Using Cadmium-Doped Iron Oxide Nanoparticles

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1. Introduction:

Water pollution threatens global access to safe drinking water. Nanomaterial-based adsorption provides an efficient, low-cost treatment strategy. This study synthesized and evaluated cadmium-doped iron oxide (Cd–Fe_2O_3) nanoparticles via co-precipitation, characterized by FTIR and XRD, for removing the synthetic acidic dye Acid Blue 93 from aqueous solutions.

2. Objectives:

The objectives of this study are to: synthesize Cd-doped Fe_2O_3 nanoparticles using a co-precipitation technique; evaluate their adsorption performance for Acid Blue 93 dye under various physicochemical conditions; and assess the kinetics, isotherms, thermodynamics, and reusability of the adsorbent.

3. Methodology:

Batch adsorption experiments were conducted under optimized conditions: pH 2, 0.05 g/50 mL adsorbent dosage, 90-minute contact time, 35 °C temperature, and an initial dye concentration of 150 ppm. Adsorption capacity was analyzed using pseudo-second-order kinetics and Freundlich isotherms. Thermodynamic parameters (ΔG°, ΔH°, ΔS°) were calculated to assess the spontaneity and heat exchange characteristics of the process. The effect of co-existing ions (electrolytes and heavy metals) and surfactants on adsorption efficiency was also examined. Desorption efficiency was evaluated using different eluents (0.5 N NH_4OH and 0.5 N NaOH).

4. Results:

Cd–Fe_2O_3 NPs demonstrated a maximum adsorption capacity of 35.63 mg/g under optimized conditions. The adsorption process followed pseudo-second-order kinetics ($R^2 > 0.99$) and fit well with the Freundlich isotherm model, indicating multilayer adsorption on a heterogeneous surface. Thermodynamic analysis revealed a spontaneous and endothermic process. While the presence of electrolytes and heavy metals influenced adsorption capacity, the presence of surfactants reduced removal efficiency. Among the tested eluents, both 0.5 N NH_4OH and 0.5 N NaOH showed effective dye desorption, supporting the potential for adsorbent reuse.

5. Conclusion & Recommendations:

Cd-doped Fe_2O_3 nanoparticles offer a promising solution for the efficient removal of synthetic dyes from wastewater. Their high adsorption capacity, favorable kinetic and thermodynamic profiles, and reusability make them suitable for practical applications in wastewater treatment. Future studies should explore real industrial wastewater samples, scale-up processes, and the long-term stability of the adsorbent.

Keywords: Cd Doped Fe_2O_3 Nanoparticles, Adsorption, Acid Blue-93 Dye; Kinetics, Equilibrium, Thermodynamics

The Nutritional Status of University Students in Faisalabad, Pakistan: Exploring the Role of Oral Health and Food Insecurity

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1. Introduction:

University students in Faisalabad face multiple lifestyle challenges that adversely affect their nutritional status. Key among these are food insecurity and poor oral health—factors often overlooked in conventional health assessments. Financial constraints, academic pressure, and irregular dietary habits can lead to inadequate nutrient intake, while dental issues such as pain and chewing difficulties further compromise food choices. Despite their relevance, the combined effect of food insecurity and oral health on student nutrition remains underexplored.

2. Objectives:

This study investigates the combined influence of oral health conditions and food insecurity on the nutritional well-being of university students. It also examines related socioeconomic and behavioral factors affecting diet, academic performance, and overall health. The research aims to inform institutional and policy interventions for improved student support.

3. Methodology:

A cross-sectional qualitative study was conducted with 243 university students using structured, self-administered questionnaires. Data collected included demographic profiles, food security status, oral health issues, and perceived links between diet and academic performance. Descriptive statistics and thematic analysis were used for data interpretation.

4. Results:

Findings revealed that 38.5% of students experienced moderate-to-severe food insecurity, while 26% reported oral health problems such as chewing discomfort and untreated dental issues. Financial limitations led many to rely on calorie-dense, nutrient-poor diets. These constraints, compounded by oral health difficulties, significantly reduced dietary diversity and were linked to academic underperformance, with 27% of students attributing low grades to poor nutrition. A lack of institutional support, such as affordable meal options and dental care services, worsened these outcomes.

5. Conclusion & Recommendations:

The study highlights the critical link between oral health, food security, and academic performance among university students. Poor dietary habits driven by financial and dental constraints negatively impact both well-being and learning outcomes. Recommendations include the establishment of campus-based health clinics offering affordable nutrition and dental services, partnerships with local food vendors for subsidized healthy meals, and integration of health literacy programs into academic curricula. These interventions can help foster a healthier, more resilient student population.

Keywords: Oral Health, Food Insecurity, Nutritional Status, Academic Performance, University Students

Green Synthesized Zinc Oxide Nanoparticles of Medicinal Plants as Eco-Friendly Bio-Insecticides Against House Fly (Musca domestica)

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1. Introduction:

The house fly (Musca domestica) is a major pest and disease vector, transmitting typhoid, cholera, dysentery, polio, tuberculosis, and others. Overuse of conventional insecticides raises ecological and health concerns, encouraging eco-friendly alternatives. Nanotechnology, particularly green-synthesized nanoparticles, offers a promising, sustainable strategy for pest and vector management.

2. Objectives:

This study aims to evaluate the efficacy of four plant-based extracts, *Nerium oleander* (Kaner) leaves, *Allium sativum* (garlic) cloves, *Moringa oleifera* (Moringa) leaves, and *Datura stramonium* (Datura) leaves, along with their green-synthesized zinc oxide (ZnO) nanoparticles against Musca domestica. The goal was to determine their potential as environmentally friendly insecticidal agents.

3. Methodology:

ZnO nanoparticles were synthesized using plant extracts and confirmed via UV spectroscopy. A laboratory bioassay, designed under a CRD, tested five concentrations of plant extracts and ZnO NPs against control. Mortality was recorded at 24–72 hours, corrected with Abbott's formula, and analyzed using Tukey's HSD at 5% significance.

4. Results:

The highest mortality rate among plant extracts was observed with D. stramonium (93.14%) at a 20% concentration after 72 hours, followed by N. oleander (89.73%), A. sativum (86.27%), and M. oleifera (82.19%). Among the ZnO nanoparticle formulations, A. sativum-based ZnO NPs caused the highest mortality (92.65%) at 240 ppm, followed by M. oleifera (91.17%), D. stramonium (90.35%), and N. oleander (90.13%). All treatments exhibited a concentration- and time-dependent mortality response, with no mortality observed in control groups. The enhanced efficacy of ZnO nanoparticles over crude plant extracts highlights their potential as more effective and sustainable alternatives for insect pest management.

5. Conclusion & Recommendations:

The results suggest that green-synthesized ZnO nanoparticles, derived from plant extracts, offer a promising and eco-friendly approach to controlling Musca domestica. The use of these nanoparticles in integrated pest management programs can be an effective and sustainable strategy, reducing reliance on conventional insecticides. Future research should focus on field trials to evaluate the long-term effectiveness, ecological safety, and potential integration of this approach into broader pest management frameworks.

Keywords: Musca Domestica, Zinc Oxide Nanoparticles, Green Synthesis, Plant Extracts, Insecticidal Activity, Sustainable Pest Management

Insecticidal Efficacy of Phytobiopesticides and Parthenium-Derived Nanomaterials Against Tribolium Castaneum and Oryzaephilus Surinamensis

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1. Introduction:

Insect pests cause significant economic losses to stored food products worldwide. Traditionally, chemical insecticides and phosphine fumigation are employed for pest control; however, resistance to these methods, particularly in developing countries, has emerged as a major challenge. This highlights the urgent need for alternative control methods. Plant-based biopesticides, which are eco-friendly and exhibit low toxicity to humans and animals, are emerging as viable solutions.

2. Objectives:

The aim of this study was to evaluate the insecticidal efficacy of crude extracts from *Parthenium* and zinc oxide (ZnO) nanoparticles synthesized using *Parthenium* extract against two common storage pests: the saw-toothed grain beetle (*Oryzaephilus surinamensis*) and the red flour beetle (*Tribolium castaneum*).

3. Methodology:

Crude extracts of *Parthenium* were prepared and used to synthesize ZnO nanoparticles. Six concentrations (100, 200, 300, 400, 500, and 600 ppm) of each treatment were tested in a completely randomized design (CRD), with three replicates and control treatments. In each replicate, 20 insects were released, and mortality was recorded at 1, 3, 5, and 7 days. Data were analyzed using Tukey's HSD test at a 5% significance level.

4. Results:

ZnO nanoparticles exhibited a strong dose-dependent toxicity against both *O. surinamensis* and *T. castaneum*. Mortality increased with concentration, from 12% (at 100 ppm) to 80% (at 600 ppm) for *T. castaneum*, and from 16% (at 100 ppm) to 75% (at 600 ppm) for *O. surinamensis*. In contrast, the crude *Parthenium* extract showed lower toxicity, with maximum mortalities of 51% (for *T. castaneum*) and 54% (for *O. surinamensis*) at 600 ppm, and significantly lower mortality at 100 ppm (16% for *T. castaneum* and 13% for *O. surinamensis*).

5. Conclusion & Recommendations:

The study demonstrates that ZnO nanoparticles derived from *Parthenium* exhibit strong insecticidal activity against both *O. surinamensis* and *T. castaneum*, suggesting their potential as an effective and eco-friendly alternative to conventional synthetic insecticides for managing stored-product pests. While crude *Parthenium* extract also exhibited insecticidal effects, its efficacy was lower compared to ZnO nanoparticles. Further research is recommended to explore the field application of these nanoparticles, assess their long-term effectiveness, and evaluate their potential for integration into pest management programs in storage facilities.

Keywords: *Oryzaephilus Surinamensis*, *Tribolium Castaneum*, Zinc Oxide Nanoparticles, Parthenium Extract, Biopesticides, Stored-Product Pest Management

Bioactivity of Nanoparticles of ZnO Synthesized By The Extract of *Zingiber Officinale* Against Stored Products Insect Pests

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1. Introduction:

Post-harvest grain losses from insect pests like Tribolium castaneum and Oryzaephilus surinamensis threaten global food security. Chemical pesticides, though effective, pose health and environmental concerns. This study evaluates eco-friendly ZnO nanoparticles synthesized from Zingiber officinale extract for their insecticidal efficacy and growth-inhibiting potential as sustainable pest management alternatives.

2. Objectives:

The primary objective of this study was to evaluate the insecticidal and growth-inhibitory effects of ZnO nanoparticles synthesized from *Zingiber officinale* rhizome extract against *T. castaneum* and *O. surinamensis*. Additionally, the insecticidal effects of crude ginger extract alone were compared to those of the synthesized nanoparticles.

3. Methodology:

ZnO nanoparticles were green-synthesized using Zingiber officinale rhizome extract and tested at five concentrations (3200–6400 ppm) for contact toxicity and growth inhibition. Parallel bioassays with ginger extract (5–25%) were performed. Mortality was recorded at 24–72 hours, and developmental suppression assessed via diet incorporation bioassays.

4. Results:

The ZnO nanoparticles showed a strong dose-dependent response in both insect species. At the highest concentration (6400 ppm), ZnO nanoparticles caused up to 90% mortality in *T. castaneum* and 95% mortality in *O. surinamensis*. Growth inhibition followed a similar pattern, with 90% and 85% suppression in *T. castaneum* and *O. surinamensis*, respectively. In comparison, crude ginger extract demonstrated moderate insecticidal effects, with maximum mortalities of 75% for *T. castaneum* and 80% for *O. surinamensis* at the 25% concentration. The growth inhibition from ginger extract was also lower than that of the nanoparticles.

5. Conclusion & Recommendations:

The study indicates that ZnO nanoparticles synthesized using *Zingiber officinale* extract exhibit strong insecticidal activity and growth inhibition against *T. castaneum* and *O. surinamensis*. These nanoparticles outperform the crude ginger extract, highlighting the synergistic potential of nanotechnology and plant-based agents in integrated pest management (IPM) systems. The findings support the development of biogenic nanomaterials as a viable, eco-friendly alternative to conventional chemical pesticides for the protection of stored food commodities. Further research is needed to assess the practical application and long-term efficacy of these nanoparticles in real-world pest management scenarios.

Keywords: Stored Product Pest, Biopesticides, Nanotechnology, Zinc Oxide Nanoparticles, Insecticidal Activity, Ginger Extract

Assessment of Systemic Insecticide Premixtures for Aphid Management and Their Non-Target Effects in Canola Ecosystems

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1. Introduction:

Lipaphis erysimi (mustard aphid) poses a major threat to canola (Brassica napus), causing stunted growth, leaf curling, virus transmission, and economic losses. Although insecticides control aphids, they also harm beneficial predators like coccinellids. This study evaluates systemic insecticide premixes for aphid suppression and their ecological impact on predator populations.

2. Objectives:

The aim of this study was to evaluate the efficacy of four systemic insecticide premixes for aphid control in canola fields, and to examine their effects on coccinellid populations, in order to provide insights for sustainable pest management strategies.

3. Methodology:

Four insecticide premixes, Cypermethrin + Profenofos, Flonicamid + Pyriproxyfen + Acetamiprid, Acetamiprid + Lambda-cyhalothrin, and Triazophos + Betacyfluthrin, were evaluated in canola fields. Aphid populations were monitored at 24, 72, and 168 hours post-treatment. Concurrently, coccinellid abundance was recorded to assess non-target impacts. Data determines control efficacy and ecological consequences.

4. Results:

Cypermethrin + Profenofos and Flonicamid + Pyriproxyfen + Acetamiprid were the most effective treatments against aphids, achieving 80.78% and 77.56% reduction, respectively, after 168 hours. Acetamiprid + Lambda-cyhalothrin showed moderate efficacy with a 64.49% reduction, while Triazophos + Betacyfluthrin reached 73.65% reduction, though with more variability. These treatments, however, impacted coccinellid populations differently. Acetamiprid + Lambda-cyhalothrin caused the largest decline, reducing coccinellids by 79% at 72 hours, whereas Cypermethrin + Profenofos and Flonicamid + Pyriproxyfen + Acetamiprid also decreased predator numbers, but less severely.

5. Conclusion & Recommendations:

The study demonstrates that while certain insecticide premixes, such as Cypermethrin + Profenofos and Flonicamid + Pyriproxyfen + Acetamiprid, are highly effective for aphid control, their potential to negatively impact natural enemy populations, particularly coccinellids, cannot be ignored. These findings highlight the importance of selecting insecticides that provide effective pest control while minimizing harm to beneficial insect species. The study underscores the value of Integrated Pest Management (IPM), which balances chemical control methods with the conservation of natural predators, to ensure long-term productivity and ecological health in canola production systems.

Keywords: *Lipaphis Erysimi*, *Brassica Napus*, Insecticides, Coccinellids, Integrated Pest Management, Aphid Control, Ecological Impact

Enhanced Management of House Cricket (Acheta Domestica) Through Food-Based Baits and Insecticide Synergy Under Laboratory Conditions

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1. Introduction:

The house cricket (Acheta domestica) is a destructive pest of household items, stored food, and crops. Its polyphagous feeding, rapid reproduction, and adaptability make it problematic in urban and agricultural settings. This study evaluates food-based baits and insecticides, individually and combined, for effective laboratory-based management strategies.

2. Objectives:

This study aimed to evaluate the attractiveness of various food-based baits and the toxicity of insecticides, cypermethrin, deltamethrin, and imidacloprid, both individually and when combined with baits. The objective was to identify the most effective combinations that could enhance the management of *A. domestica* infestations in an environmentally safe manner.

3. Methodology:

The study was conducted in three phases: first, an olfactometer bioassay to identify the most attractive bait; second, toxicity tests of insecticides alone; and third, combined trials of insecticides with baits to evaluate synergistic effects. A completely randomized design with three replications was employed, recording mortality at 24, 48, 72, and 96 hours. Insecticides were tested at five concentrations (12.5–200 ppm), and baits included cornmeal, honey, vegetable oil, sugar, and corn flour.

4. Results:

Among the food-based baits, cornmeal combined with honey attracted the highest number of crickets (80%), followed by cornmeal with vegetable oil (65%), sugar (50%), and corn flour (30%). Toxicity tests showed all insecticides caused increasing mortality over time, with cypermethrin being the most effective, achieving 79.33% mortality at 200 ppm after 96 hours. LC_{50} values at 96 hours were 41.50 ppm for cypermethrin, 52.33 ppm for deltamethrin, and 155.18 ppm for imidacloprid. Combining cypermethrin with honey-based bait yielded the highest mortality (82%) and a lower LC_{50} (32.39 ppm) compared to vegetable oil-based bait (67% mortality, LC_{50} 82.76 ppm).

5. Conclusion & Recommendations:

This study shows that combining food-based baits with insecticides enhances house cricket management. Cypermethrin with honey-based bait achieved the highest mortality, reduced lethal concentrations, and faster lethal times. Such bait-insecticide synergy offers a targeted, efficient, and eco-safer alternative, supporting sustainable control within integrated pest management (IPM) programs.

Keywords: *Acheta Domestica*, Insecticides, Food-Based Baits, Cypermethrin, Deltamethrin, Imidacloprid, Integrated Pest Management, House Cricket Control

Optimizing Dietary Regimes for Mass Rearing of Rhizoglyphus Tritici to Enhance Biological Control Efficiency of Neoseiulus Barkeri

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Introduction:

Predatory mites like Neoseiulus barkeri are key agents in biological control programs. Their mass production depends on rearing factitious hosts, especially Rhizoglyphus tritici. Host diet critically affects reproduction, survival, and population growth. This study evaluates different food types for R. tritici under laboratory conditions to optimize mass-rearing and enhance biological control efficiency.

2. Objectives:

The aim of this study was to examine how seven different food types, including maize bran, wheat, wheat bran, wheat porridge, and their combinations, affect the population growth of *R. tritici* in laboratory settings. The study also tracked several biological parameters to determine the most effective diet for *R. tritici* rearing.

3. Methodology:

A completely randomized design (CRD) with three replications per treatment was used. In each setup, 100 adult *R. tritici* mites were placed in 100 ml plastic containers containing 25 grams of diet. The containers were maintained at a constant temperature of 25 ± 2°C, 70% relative humidity, and a 16:8 hour light-dark cycle. Mite populations were counted weekly for four weeks. Biological parameters such as fecundity (total and daily), egg incubation time, larval stages, nymphal duration, oviposition periods, and adult lifespan were also recorded. Statistical analysis was performed using one-way ANOVA, and Tukey's HSD test was used to determine differences between treatments.

4. Results:

The wheat and bran combination supported the highest population growth of *R. tritici*, with an average of 4,700 mites per replicate. Wheat alone resulted in 3,600 mites, followed by the wheat and porridge combination (3,350), wheat bran (3,000), wheat porridge (2,700), and maize bran, which supported the fewest mites (1,800 per replicate). Statistical analysis indicated that the wheat and bran mixture significantly outperformed all other diets in promoting mite reproduction ($p < 0.05$).

5. Conclusion & Recommendations:

The wheat and bran combination proved most effective for enhancing R. tritici population growth, outperforming other diets. These findings inform optimized mass-rearing strategies, supporting the production of predatory mites like N. barkeri and improving the cost-effectiveness and efficiency of biological pest control in sustainable management programs.

Keywords: *Neoseiulus Barkeri*, *Rhizoglyphus Tritici*, Biological Control, Mass Rearing, Population Growth, Food Sources, Sustainable Pest Control

Evaluation of Behavioral Response and Mortality of House Crickets using Food-Based Baits Combined with Insecticides Under Olfactometric Assay

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1. Introduction:

The house cricket (Orthoptera: Gryllidae) damages household fabrics and stored materials. While they have some environmental and nutritional benefits, they are mainly pests. This study evaluates the behavioral response and mortality of house crickets to various food-based baits combined with insecticides under laboratory conditions.

2. Objectives:

The objective of this study was to assess the behavioral attraction of house crickets to different food-based baits and their subsequent mortality when combined with selected insecticides (permethrin, fipronil, bifenthrin, and imidacloprid) at various concentrations. The study used olfactometry to evaluate cricket behavior and measured mortality over time.

3. Methodology:

Food-based baits were formulated using attractants including vinegar, yeast, molasses, vanilla extract, sugar solution, wheat bran, and wheat flour, combined with insecticides (permethrin, fipronil, bifenthrin, and imidacloprid) at various concentrations. Behavioral responses were assessed via a six-armed olfactometer, mortality recorded at 24–96 hours, and a CRD design used. LC_{50} and LT_{50} values were calculated for analysis.

4. Results:

Among the insecticides tested, fipronil proved to be the most effective, achieving the highest mortality (96.6%) at its highest concentration after 96 hours, followed by bifenthrin (83.3%), imidacloprid (76.6%), and permethrin (63.3%). The combination of fipronil with a sugar solution bait resulted in the highest attraction and a mortality rate of 83.8%, followed by vanilla extract (63.3%) when wheat flour was used as the base in both cases. Statistical analysis revealed significant differences among treatments. Fipronil exhibited the highest LC_{50} (1005.04) and the lowest LT_{50} (69.588), indicating its strong toxicity and rapid action. It was followed by bifenthrin (LC_{50}: 880.638, LT_{50}: 103.107), imidacloprid (621.430, 131.336), and permethrin (303.972, 143.391).

5. Conclusion & Recommendations:

The study shows that food-based baits combined with insecticides, particularly fipronil, effectively control house cricket populations. Fipronil exhibited high toxicity and rapid action, highlighting the potential of bait–insecticide combinations as a targeted, efficient strategy for managing infestations.

Keywords: *Orthoptera*, House Cricket, Insecticides, Fipronil, Food-based Baits, Pest Management, Behavioural Response

Efficacy of Botanical Extracts Combined with Synthetic Insecticides Against Larval Stages of Musca Domestica Under Laboratory Conditions

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Introduction:

The housefly (Musca domestica) spreads numerous diseases, posing health risks to humans and animals. Due to environmental concerns and insecticide resistance, this study evaluates plant-based extracts combined with chemical insecticides as an eco-friendly alternative for controlling housefly larvae.

2. Objectives:

The objective of this study was to assess the efficacy of four plant-based extracts (*Azadirachta indica*, *Piper nigrum*, *Eucalyptus globulus*, and *Citrus aurantifolia*) when used in combination with two chemical insecticides (*lambda-cyhalothrin* and *acetamiprid*) in controlling housefly larvae. The study also aimed to determine the lethal concentration (LC_{50}) values for each treatment to evaluate their relative toxicity.

3. Methodology:

Plant extracts were tested at five concentrations (1.25–20%), while lambda-cyhalothrin (3.75–60 ppm) and acetamiprid (6.25–100 ppm) were assessed at five doses. A completely randomized design with three replications was used, recording larval mortality at 24, 48, 72, and 96 hours, and calculating LC_{50} values.

4. Results:

Among the plant extracts, *Piper nigrum* was the most effective, causing 95% larval mortality at a concentration of 20%, followed by *Azadirachta indica* (88.33%), *Citrus aurantifolia* (76.65%), and *Eucalyptus globulus* (76.65%) after 96 hours. Among the chemical insecticides, *acetamiprid* caused 70% mortality at 100 ppm, while *lambda-cyhalothrin* caused 60% mortality at 60 ppm. The LC_{50} values indicated that *Piper nigrum* was the most toxic (390.82), followed by *Azadirachta indica* (507.48), *Eucalyptus globulus* (1306.52), and *Citrus aurantifolia* (1636.99). For the chemical insecticides, the LC_{50} for *acetamiprid* was 9988, and for *lambda-cyhalothrin*, it was 1333.8.

5. Conclusion & Recommendations:

The study demonstrates that plant extracts, particularly *Piper nigrum*, can be effectively combined with insecticides to enhance the control of housefly larvae. The use of *Piper nigrum* in combination with *acetamiprid* or *lambda-cyhalothrin* significantly improved mortality rates, suggesting that plant-based extracts can help reduce the reliance on strong chemical insecticides. These findings provide a promising approach for developing more eco-friendly and sustainable pest control strategies for houseflies, reducing the environmental impact of chemical insecticides while maintaining pest control efficacy.

Keywords: *Musca domestica*, Housefly, Plant Extracts, Insecticides, *Piper nigrum*, Eco-friendly Pest Control, LC_{50}, Sustainable Pest Management

Comparative Bio efficacy of Botanical Extracts and Synthetic Insecticides Against Larval Stages of Musca Domestica Under Controlled Conditions

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Introduction:

House flies (Musca domestica) are major public health pests and disease vectors, particularly in Pakistan. With resistance and environmental concerns limiting synthetic insecticide effectiveness, this study evaluates the larvicidal potential of Azadirachta indica, Allium sativum, and Piper nigrum extracts versus permethrin, deltamethrin, and alpha-cypermethrin under laboratory conditions.

Objectives:

The objective of this study was to compare the larvicidal effects of plant extracts and synthetic insecticides, calculating the mortality rates and lethal concentration (LC_{50}) values for each treatment. This study aims to identify potential plant-based alternatives for managing house fly infestations while reducing reliance on synthetic chemicals.

Methodology:

A residual film bioassay was used to test the insecticidal effects of various treatments at different concentrations. The treatments were tested at 24, 48, 72, and 96 hours. Mortality rates were recorded, and LC_{50} values were calculated using ANOVA, Tukey's HSD test, and probit analysis. The plant extracts tested were neem, garlic, and black pepper, while the synthetic insecticides tested were permethrin, deltamethrin, and alpha-cypermethrin.

Results:

Among synthetic insecticides, deltamethrin and alpha-cypermethrin were most effective, causing rapid house fly larval mortality. Deltamethrin achieved 94% at 6000 ppm after 24 hours, reaching 100% by 96 hours, while alpha-cypermethrin caused 92% at 20,000 ppm, also reaching 100% at 96 hours. Permethrin showed 90% mortality at 4000 ppm, attaining full mortality by 96 hours. Among plant extracts, black pepper and neem exhibited notable larvicidal activity, with neem causing 56% mortality at 20% concentration after 24 hours (94% by 96 hours) and black pepper reaching 70% at 24 hours (94% by 96 hours). Garlic was slower, achieving 66% at 24 hours and 90% at 96 hours. LC_{50} values declined over time for all treatments.

Conclusion & Recommendations:

The results indicate that certain plant extracts, especially black pepper and neem, can be effective alternatives to synthetic insecticides in controlling house fly larvae. These plant-based treatments not only show strong larvicidal activity but also have lower environmental and health risks compared to chemical insecticides. The use of plant extracts, particularly in combination with insecticides, could provide a more sustainable approach to managing house fly infestations and reduce the dependency on synthetic chemicals.

Keywords: *Musca domestica*, House Fly, Plant Extracts, Synthetic Insecticides, Neem, Garlic, Black Pepper, Insecticidal Activity, LC_{50}, Sustainable Pest Management

Transgenerational Impact of ZnO Nanoparticles and Nucleopolyhedrovirus on Cotesia Marginiventris: Implications for Sustainable Armyworm Management in IPM Systems

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Introduction:

Armyworms (Spodoptera spp.) are major agricultural pests causing significant crop losses. This study evaluates the effects of zinc oxide nanoparticles (ZnO NPs) and Spodoptera frugiperda multiple nucleopolyhedrovirus (SfMNPV) on Cotesia marginiventris, a key parasitoid used for sustainable biological control of fall armyworms.

Objectives:

The objective of this study was to examine the effects of sublethal exposure to ZnO NPs and SfMNPV on the survival, reproduction, host-location ability, and oxidative stress levels of *C. marginiventris* across two generations. The study also assessed whether combining NPs and NPVs affected parasitoid health and behavior, providing insights into their compatibility in integrated pest management (IPM) programs.

Methodology:

The parent generation (F_0) of Cotesia marginiventris was exposed to sublethal ZnO NPs (50, 200 mg/L) and SfMNPV (1×10^4, 1×10^6 PIBs/mL). The F_1 generation was assessed for survival, reproduction, host-searching ability, and oxidative stress. Combined effects and concentration responses were analyzed using ANOVA, Tukey's HSD, probit, and regression analyses.

Results:

Exposure to both ZnO NPs and SfMNPV had significant effects on *C. marginiventris* fitness across generations. In the F0 generation, exposure to ZnO NPs and SfMNPV resulted in decreased survival and reproductive success. The F1 generation exhibited impaired host-location ability and increased oxidative stress, suggesting potential long-term effects of these treatments. The combined exposure to ZnO NPs and SfMNPV did not result in synergistic effects but instead indicated potential interference between the two, which could further impact parasitoid performance. The LC_{50} values for the treatments were calculated, and significant differences in parasitoid health and behavior were observed across different concentrations and combinations of ZnO NPs and SfMNPV.

Conclusion & Recommendations:

This study highlights potential ecological risks of combining nanoparticles and biopesticides in pest control. Findings emphasize evaluating long-term effects on non-target beneficial insects, such as parasitoids, to maintain environmentally sustainable IPM strategies. The results offer insights into NP and NPV compatibility, guiding responsible use to balance effective pest suppression with conservation of beneficial insects, thereby supporting long-term agricultural sustainability and ecosystem health.

Keywords: *Spodoptera frugiperda*, *Cotesia marginiventris*, Nanoparticles, Nucleopolyhedrovirus, Integrated Pest Management, Ecological Safety, Biological Control, Oxidative Stress

Molecular Characterization and Bio efficacy of Nucleopolyhedroviral Isolates against Spodoptera spp. for Sustainable Armyworm Management

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1. Introduction:

Armyworms (Spodoptera spp.) are destructive pests of maize, wheat, rice, and sugarcane, causing major economic losses. Rapid reproduction and insecticide resistance complicate control. Overuse of chemicals harms the environment and beneficial insects, highlighting the need for sustainable alternatives like nucleopolyhedroviruses (NPVs), which require molecular identification for effective, species-specific pest management.

2. Objectives:

This study aimed to identify *Spodoptera* species and their associated NPVs using DNA barcoding and phylogenetic analysis, and to evaluate the efficacy of different NPV isolates against armyworm larvae. The goal was to identify the most effective viral strains for pest control and to contribute to the development of molecular techniques for improving biological control programs.

2. Methodology:

The study was conducted at the Department of Entomology, University of Agriculture, Faisalabad. Armyworm larvae and virus-infected samples were collected from multiple Punjab locations. DNA was extracted, PCR-amplified, and sequenced to assess genetic variation in Spodoptera species and associated NPVs. Phylogenetic analysis determined genetic relationships, while laboratory bioassays evaluated the virulence of different NPV isolates, with mortality data analyzed using Probit analysis in SPSS to identify the most effective biological control agents.

3. Results:

The molecular analysis revealed distinct genetic variations among the *Spodoptera* species and the NPVs isolated from them. Several NPV strains exhibited high efficacy in killing armyworm larvae. The Probit analysis indicated that certain NPV isolates caused significant mortality in the larvae, with some isolates demonstrating higher virulence than others. These findings highlight the genetic differences among the NPV isolates and their varying effectiveness in pest control.

4. Conclusion & Recommendations:

This research identifies the most effective NPV strains for controlling armyworm larvae, supporting the potential of NPVs as a viable alternative to chemical pesticides in sustainable pest management. The study also underscores the importance of molecular identification and genetic analysis in optimizing biological control programs. By selecting the most virulent NPV isolates, this research contributes to enhancing the efficiency of biological pest control, thereby protecting crops in an environmentally responsible manner. Future research should focus on field applications of these NPV isolates and explore their integration into integrated pest management (IPM) programs.

Keywords:
Spodoptera spp., Armyworms, Nucleopolyhedroviruses, Biological Control, DNA Barcoding, Phylogenetic Analysis, Pest Management, Integrated Pest Management

Field Evaluation of Seed-Applied Insecticides for Early-Season Management of Wheat Aphids and Implications for Integrated Pest Control

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1. Introduction:

Wheat (Triticum aestivum L.) is a vital crop in Pakistan, threatened by aphids, Rhopalosiphum padi, Schizaphis graminum, and Sitobion avenae, which damage plants and transmit Barley Yellow Dwarf Virus (BYDV). This study evaluates six seed-applied insecticides for controlling aphids under field conditions over a 12-week period.

2. Objectives:

The objective of this study was to assess the efficacy of six different seed-applied insecticides on controlling aphid populations in wheat fields. The study aimed to evaluate the insecticides' performance over time and determine the potential need for integrated pest management (IPM) strategies for more sustained aphid control.

3. Methodology:

The field trial was conducted over 12 weeks, testing six seed-applied insecticides: Actara (thiamethoxam), Argyl Super (clothianidin + azoxystrobin), Combinex Ultr (fludioxonil + azoxystrobin), Cruiser (thiamethoxam), Fortenza (cyantraniliprole), and Hombre (imidacloprid + tebuconazole). Aphid populations were monitored weekly, and data were analyzed using ANOVA and Tukey's HSD to assess the effectiveness of each insecticide and the influence of time. Aphid counts were recorded per 10 tillers at weekly intervals.

4. Results:

Actara provided the best early-season control, with the lowest mean aphid count (0.236 per 10 tillers) during the first four weeks. It was followed by Argyl Super (0.359), Cruiser (0.432), Fortenza (0.565), Combinex Ultr (0.753), and Hombre (0.779). Statistical analysis showed significant effects for insecticide type ($F = 13.51$, $p = 0.000$), week ($F = 50.10$, $p = 0.000$), and their interaction ($F = 84.44$, $p = 0.000$). Although Actara and Argyl Super were the most effective in the initial weeks, their performance declined after Week 4, with aphid numbers peaking between Weeks 7 and 9 across all treatments. By the end of the trial, in Weeks 11 and 12, aphid populations in treated plots were like those in untreated control, suggesting that insecticide effectiveness waned over time.

5. Conclusion & Recommendations:

The study demonstrates that seed-applied insecticides provide effective early-season protection against aphids, but their efficacy diminishes over time, likely due to insecticide degradation or aphid resurgence. For more reliable, season-long aphid control, the study recommends adopting integrated pest management (IPM) practices. Combining insecticides with cultural and biological control methods could help maintain aphid populations below damaging levels throughout the growing season.

Keywords: Wheat, Aphid Control, Seed-applied Insecticides, Integrated Pest Management, *Rhopalosiphum padi*, *Schizaphis graminum*, *Sitobion avenae*, Barley Yellow Dwarf Virus

Varietal Resistance and Population Dynamics of Aphids and Predators in Wheat Under-Field Conditions in Relation to Abiotic Factors

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1. Introduction:

Wheat (Triticum aestivum L.) in Pakistan faces yield losses from seasonal aphid outbreaks, which vary among genotypes. Aphids damage plants and transmit viruses, reducing crop quality. This study monitors weekly aphid populations and natural predators across ten wheat genotypes in Faisalabad (2024–2025), examining weather effects on pest dynamics.

2. Objectives:

The objective of this study was to examine aphid populations and their natural predators on ten wheat genotypes over the course of the growing season, and to assess how weather conditions, particularly temperature and humidity, influence both aphids and their predators.

3. Methodology:

The study was conducted in Faisalabad during the 2024–2025 wheat season, monitoring ten wheat genotypes from emergence to harvest. Weekly aphid counts and sweep net sampling of natural predators, including ladybird beetles and syrphid flies, were conducted. Temperature and humidity were recorded, and data were analyzed using general linear models and correlation analysis to examine aphid dynamics, predator abundance, and the influence of weather conditions on pest populations.

4. Results:

Analysis revealed significant weekly fluctuations in aphid populations across eight wheat varieties, with Champion ($F = 11.01$, $R^2 = 83.47\%$), Arooj ($F = 10.31$, $R^2 = 82.53\%$), and Akbar ($F = 8.23$, $R^2 = 79.05\%$) showing the highest infestations, particularly between Weeks 7–9. Subhani ($F = 1.54$, $p = 0.181$) and Fakhar-e-Bhakar ($F = 1.38$, $p = 0.246$) maintained low aphid numbers, indicating natural resistance. Ladybird beetle populations peaked in Week 7 ($F = 8.15$, $p < 0.001$), while syrphid flies remained minimal. Aphid populations showed no significant correlation with temperature ($r = 0.034$, $p = 0.524$) or humidity ($r = 0.066$, $p = 0.215$), though ladybird beetles had a weak positive correlation with temperature ($r = 0.208$, $p = 0.000$).

5. Conclusion & Recommendations:

The findings suggest that the wheat variety itself plays a more significant role in controlling aphid populations than the activity of natural predators or weather conditions. Resistant varieties such as *Subhani* and *Fakhar-e-Bhakar* provided more stable protection against aphid build-up and should be prioritized in breeding programs and integrated pest management (IPM) strategies. These varieties could offer a sustainable, long-term solution for aphid control in wheat production systems, reducing the need for chemical interventions and supporting more eco-friendly agricultural practices.

Keywords:
Wheat, Aphid Control, *Rhopalosiphum padi*, *Schizaphis graminum*, *Sitobion avenae*, Natural Predators, Ladybird Beetles, Syrphid Flies, Integrated Pest Management, Wheat Resistance

Geographic Variation in Insecticide Efficacy and Resistance Patterns of Musca Domestica in Punjab Pakistan and Implications for District-Specific IPM Strategies

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1. Introduction:

Houseflies (Musca domestica) are common pests near human settlements, transmitting over 100 pathogens and causing health and economic issues. Rising resistance limits chemical control. This study evaluates the efficacy of deltamethrin, fipronil, and chlorpyrifos against housefly larvae and adults in Lahore and Rahim Yar Khan, Pakistan.

2. Objectives:

The objective of this study was to compare the larvicidal and adulticidal efficacy of deltamethrin, fipronil, and chlorpyrifos against houseflies in two locations with differing levels of insecticide use. The study also aimed to assess resistance development in housefly populations by comparing resistance ratios (RR_{50}) to a known susceptible strain.

3. Methodology:

Laboratory bioassays evaluated the efficacy of deltamethrin, fipronil, and chlorpyrifos against housefly larvae and adults at different concentrations. Third-instar larvae were used for larvicidal tests, while adult mortality was recorded over 72 hours. Mortality data were analyzed using ANOVA, and resistance ratios (RR_{50}) were calculated relative to a susceptible strain. Experiments were conducted in Lahore and Rahim Yar Khan to compare regional responses.

4. Results:

Larvicidal bioassays revealed a clear concentration-dependent effect on housefly mortality. At 10 ppm in Lahore, deltamethrin, fipronil, and chlorpyrifos caused 46.67%, 35.56%, and 40.00% mortality, respectively, whereas in Rahim Yar Khan, mortality was markedly higher: 86.67%, 100.00%, and 95.56% ($F \approx 97–99$, $p < 0.0001$). Adult tests over 72 hours showed deltamethrin caused 91.11% mortality in Lahore, with fipronil and chlorpyrifos achieving near-complete mortality. Resistance ratios (RR_{50}) indicated increasing resistance to deltamethrin (10.3–35.4) and fipronil (17.5–38.1), particularly in high-use areas, while resistance to chlorpyrifos remained lower ($RR_{50} < 20$).

5. Conclusion & Recommendations:

The study highlights significant regional differences in the effectiveness of insecticides, with higher mortality rates observed in Rahim Yar Khan compared to Lahore. Resistance development was noted, particularly to deltamethrin and fipronil, indicating the need for ongoing monitoring and resistance management. Chlorpyrifos remains relatively effective, but its continued use should be balanced with alternative control strategies. The results emphasize the importance of location-specific pest control strategies, rotating insecticides, and integrating them into integrated pest management (IPM) programs to slow resistance development and ensure long-term control of houseflies.

Keywords: *Musca domestica*, Housefly, Insecticides, Resistance, Deltamethrin, Fipronil, Chlorpyrifos, Larvicidal Activity, Integrated Pest Management, Regional Differences

Population Dynamics of Insect Pests and Insectivorous Arthropods on Rose and Chrysanthemum Crops in Faisalabad Punjab Pakistan during Spring Season

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1. Introduction:

Roses (Rosa spp.) and chrysanthemums (Chrysanthemum spp.) are globally important ornamental flowers used in landscaping, cosmetics, and traditional remedies. Pest infestations, including aphids and caterpillars, threaten yield and quality, worsened by climate change. This study monitored pest and natural predator populations to understand and improve pest management strategies.

2. Objectives:

The objective of this study was to monitor the occurrence of insect pests and their natural predators in rose and chrysanthemum fields during the spring of 2024. By identifying key pests and their associated predators, the study aims to contribute to the development of effective Integrated Pest Management (IPM) strategies for these ornamental crops.

3. Methodology:

A field survey was conducted at the Floriculture Area, University of Agriculture, Faisalabad. Six blocks were studied, rose (30 rows) and chrysanthemum (24 rows). Weekly, one plant per row was inspected to record insect pests, including aphids, bugs, and caterpillars, alongside natural predators like syrphid flies, ladybird beetles, and spiders.

4. Results:

In rose fields, aphids, particularly *Macrosiphum rosae*, were the most frequent pests, followed by leafhoppers (*Edwardsiana rosae*) and thrips (*Thrips fuscipennis*). In chrysanthemums, the false chinch bug (*Nysius raphanus*) dominated, with *Macrosiphoniella sanborni* also prevalent. Chewing pests like sawflies (*Agro ochropus*) and cotton leafworms (*Spodoptera littoralis*) appeared occasionally in both crops. Among natural predators, syrphid flies (*Syrphus ribesii*) were most common in roses, followed by seven-spotted ladybird beetles (*Coccinella septempunctata*) and spiders. In chrysanthemums, variegated ladybird beetles (*Hippodamia variegata*) and spiders were abundant, while syrphid fly populations remained stable. Overall, insectivorous arthropod populations fluctuated but persisted throughout the growing season.

5. Conclusion & Recommendations:

This study highlights the critical role of natural predators in controlling pests in ornamental crops. Conserving predators such as syrphid flies and ladybird beetles helps maintain ecological balance, reducing pest pressures. These findings support incorporating natural enemies into Integrated Pest Management (IPM) strategies. Future research should evaluate the effectiveness of IPM practices and further explore how predator populations can enhance sustainable pest control in ornamental crop production systems.

Keywords: Roses, Chrysanthemums, Insect Pests, Natural Predators, Aphids, Syrphid Flies, Ladybird Beetles, Integrated Pest Management (IPM), Ornamental Crops

Bio efficacy of Green Synthesized Silver Oxide and Zinc Oxide Nanoparticles against Trogoderma Granarium and Alphitobius Diaperinus in Stored Grain Management

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1. Introduction:

Stored grain insect pests significantly threaten global food security by reducing both the quality and quantity of stored products. Overreliance on synthetic pesticides has caused environmental issues, including resistance and harmful residues. This study evaluates green-synthesized silver oxide and zinc oxide nanoparticles against Khapra beetle (Trogoderma granarium) and Darkling beetle (Alphitobius diaperinus), aiming to identify sustainable, eco-friendly alternatives to conventional chemical pesticides for effective stored grain pest management.

2. Objectives:

The objective of this study was to evaluate the effectiveness of silver oxide and zinc oxide nanoparticles, synthesized using ginger (*Zingiber officinale*) rhizome extract as a natural reducing and stabilizing agent, in controlling *T. granarium* and *A. diaperinus*. The study also aimed to compare the mortality rates induced by these nanoparticles in both pest species over a 72-hour period.

3. Methodology:

Ginger rhizome extract was used to synthesize silver oxide and zinc oxide nanoparticles in an environmentally friendly manner. UV-spectroscopy was employed to confirm the structure of the nanoparticles. Bioassays were conducted to test the toxicity of these nanoparticles against *T. granarium* and *A. diaperinus*. Mortality was recorded at 24, 48, and 72 hours after exposure to the nanoparticles. The data were analyzed to compare the effectiveness of silver oxide and zinc oxide nanoparticles at different time points.

4. Results:

At 24 hours, silver oxide nanoparticles caused 65% mortality in Trogoderma granarium and 58% in Alphitobius diaperinus, while zinc oxide nanoparticles caused 52% and 46% mortality, respectively. After 48 hours, mortality increased to 82% for silver oxide and 69% for zinc oxide in T. granarium, and 74% and 61% in A. diaperinus. By 72 hours, silver oxide achieved 96% mortality in T. granarium and 88% in A. diaperinus, whereas zinc oxide reached 85% and 77%, respectively. Overall, silver oxide nanoparticles were more effective than zinc oxide in controlling both pest species over 72 hours.

5. Conclusion & Recommendations:

Silver oxide and zinc oxide nanoparticles synthesized using ginger extract effectively controlled stored grain pests, with silver oxide being more potent. This study highlights plant-based nanoparticles as safer, sustainable alternatives to chemical pesticides, supporting eco-friendly pest management. Further research should assess long-term effects and field applicability.

Keywords: Stored Grain Pests, Nanoparticles, Silver Oxide, Zinc Oxide, Green Synthesis, *Trogoderma granarium*, *Alphitobius diaperinus*, Sustainable Pest Control, Eco-friendly Pesticides

Biocontrol Potential of Entomopathogenic Fungi and Nematodes against Bactrocera Dorsalis and Bactrocera Zonata (Diptera: Tephritidae): A Critical Review of Efficacy and Integration Strategies

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1. Introduction:

Bactrocera dorsalis and *Bactrocera zonata* are major fruit fly pests causing severe crop losses and trade issues. Due to resistance and environmental concerns with chemical pesticides, this study evaluates entomopathogenic fungi and nematodes as sustainable biological control agents targeting life stages inaccessible to conventional insecticides.

2. Objectives:

The primary objective of this study was to assess the effectiveness of different EPF and EPN strains against *B. dorsalis* and *B. zonata*, and to identify the most effective biocontrol agents for integration into pest management programs. The study also aimed to evaluate the synergistic effects of combined EPF and EPN applications.

3. Methodology:

The study evaluated Beauveria bassiana and Metarhizium anisopliae (EPF) and Heterorhabditis bacteriophora and Steinernema carpocapsae (EPN) against larvae, pupae, and adults of B. dorsalis and B. zonata. Mortality, adult emergence, and environmental effects were monitored, with efficacy analyzed using ANOVA, LSD, and LC_{50}/LT_{50} values.

4. Results:

Among entomopathogenic fungi (EPF), Beauveria bassiana strains exhibited the highest efficacy. Strain B4 caused 90.67% adult, 61.33% pupal, and 52.67% larval mortality in B. dorsalis, while strain MBC 076 achieved 90% adult mortality at 1×10^9 cfu/mL after 12 days. Local strains WG-18 and WG-21 reduced fecundity and delayed development, enhancing population suppression. B. bassiana outperformed Metarhizium anisopliae, though strain-specific differences existed. Environmental factors, particularly temperature and humidity, significantly affected efficacy. Among entomopathogenic nematodes (EPNs), Heterorhabditis bacteriophora caused up to 95.74% larval mortality in B. zonata, while Steinernema carpocapsae showed lower mortality. Field-cage trials reduced adult emergence by 74.94% in B. zonata and 68.47% in B. dorsalis.

5. Conclusion & Recommendations:

Both EPF and EPNs effectively controlled B. dorsalis and B. zonata, with B. bassiana and H. bacteriophora being the most potent. Combined applications showed synergistic effects, supporting eco-friendly integrated pest management strategies. Further research is needed on field validation, formulation stability, cost analysis, and minimizing non-target impacts.

Keywords: *Bactrocera dorsalis*, *Bactrocera zonata*, Entomopathogenic Fungi, Entomopathogenic Nematodes, Biological Control, Integrated Pest Management, Beauveria bassiana, Heterorhabditis bacteriophora, Synergistic Effects

Comparative Toxicity of Moringa and Eucalyptus Extracts with Synthetic Insecticides against Housefly Larvae Under Laboratory Conditions

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1. Introduction:

House flies pose serious public health risks as disease vectors, especially in unhygienic areas. With rising concerns over chemical insecticides' environmental and health impacts, alternative control methods are needed. This study evaluates larvicidal effects of Eucalyptus globulus and Moringa oleifera extracts, compared with trichlorfon and cypermethrin, on housefly larvae.

2. Objectives:

The objective of this study was to compare the larvicidal effectiveness of *E. globulus* and *M. oleifera* extracts with chemical insecticides trichlorfon and cypermethrin. The study aimed to determine the mortality rates of housefly larvae and calculate the LC_{50} and LT_{50} values for each treatment to evaluate their toxicity and effectiveness over time.

3. Methodology:

Leaf extracts of Eucalyptus globulus and Moringa oleifera were incorporated into larval diets at various concentrations. Larval mortality was recorded at 24, 48, 72, and 96 hours under a completely randomized design (CRD). Data were analyzed using ANOVA, with Tukey's HSD (5% significance) for comparisons. Probit analysis in Minitab calculated LC_{50} and LT_{50} values for each treatment.

4. Results:

Both botanical and synthetic treatments significantly affected housefly larval mortality. After 96 hours, Moringa oleifera extract caused 73.33% mortality, Eucalyptus globulus 63.33%, cypermethrin 93.33%, and trichlorfon 73.33%. LC_{50} values were lowest for M. oleifera (5.45), followed by cypermethrin (11.53), E. globulus (15.24), and trichlorfon (33.80), showing M. oleifera's strong long-term toxicity. While cypermethrin induced rapid, high short-term mortality, M. oleifera exhibited sustained effects and potential transgenerational control. Life table and LC_{50} analyses confirmed all treatments reduced larval survival, development, and reproduction, highlighting the efficacy of botanical extracts alongside synthetic insecticides for integrated housefly management strategies.

5. Conclusion & Recommendations:

The study demonstrates that Moringa oleifera is an effective, environmentally safer alternative to synthetic insecticides for housefly control. While cypermethrin acts faster, M. oleifera provides stronger long-term larvicidal effects. These results support incorporating botanical extracts into sustainable pest management and IPM strategies. Further research should explore field applications and potential synergistic effects with chemical treatments.

Keywords: Houseflies, *Moringa oleifera*, *Eucalyptus globulus*, Trichlorfon, Cypermethrin, Larvicidal Activity, LC_{50}, Sustainable Pest Control, Botanical Pesticides

Evaluation of Pheromone-Based Fruit Fly Management Program through Community Surveys at UAF Campus

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1. Introduction:

Tephritid fruit flies are significant pests of horticultural and agricultural crops, causing considerable economic losses worldwide. While chemical pesticides have been effective in controlling these pests, their use raises serious environmental and health concerns. This study evaluates various fruit fly management strategies under field conditions, with a particular focus on community perception of these strategies.

2. Objectives:

The objective of this study was to evaluate the effectiveness of different fruit fly management strategies on horticultural crops, specifically guava, cucurbits, citrus, and mango. The study also aimed to assess community perceptions of these pest management techniques, including their effectiveness and environmental acceptability.

3. Methodology:

The experiment used a randomized complete block design (RCBD) over six fortnightly intervals to test seven treatments: SPLAT-MAT-ME (T1), SPLAT-MAT-BA (T2), SPLAT-BAT (T3), sanitation (T4), GF-120 (T5), Methyl Eugenol (T6), and Butanol Acetate (T7). Traps were placed in guava, cucurbits, citrus, and mango, measuring fly captures, fruit yield, and local community perceptions of the management strategies.

4. Results:

Methyl Eugenol (T6) was the most effective treatment, capturing the highest number of fruit flies (108.25 ± 10.11 per trap) and achieving the greatest crop yields. Butanol Acetate (T7) ranked second. The highest fruit drop occurred in SPLAT-MAT-BA (T2) (24.33 ± 2.71), while T7 had the lowest (19.83 ± 2.15). Minimum fruit infestation was observed in T6 (4.25 ± 0.82), followed by T7 and T1, with the highest in T3 (10.75 ± 1.31). Community feedback indicated strong support, with 82.5% noting reduced fruit fly populations and 75% expressing satisfaction with the management program.

5. Conclusion & Recommendations:

This study shows that Methyl Eugenol (T6) is the most effective fruit fly management strategy, significantly reducing populations and improving yields. Butanol Acetate (T7) also performed well, with lower fruit drop and infestation. Positive community feedback supports the program's environmental and practical benefits, highlighting attract-and-kill strategies as sustainable alternatives to chemical pesticides.

Keywords: Fruit Fly, Pheromone Traps, Splat-Mat Formulations, Attract and Kill, Community Surveys, Pest Management

Assessment of Salicylic Acid-Induced Changes in Aphid Infestation on Canola (Brassica Napus)

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1. Introduction:

Aphids are among the most destructive pests affecting canola (*Brassica napus*) crops in Pakistan, reducing both yield and quality. However, several arthropods, such as syrphid flies, spiders, and coccinellids, also play beneficial roles in canola fields through pollination and natural pest control. Salicylic acid, a plant hormone, is known to influence plant defense mechanisms and growth. This study evaluates the impact of salicylic acid on the population dynamics of arthropod fauna in canola fields and its potential use in pest management.

2. Objectives:

The objective of this study was to investigate the effects of foliar application of salicylic acid on aphid populations and beneficial arthropod communities in canola fields. The study also aimed to evaluate the impact of salicylic acid on plant growth and yield.

3. Methodology:

A field experiment was conducted during the 2024–2025 growing season at a canola field using a Randomized Complete Block Design (RCBD). Five treatments of salicylic acid were applied at concentrations of 0, 50, 100, 150, and 200 mg/L, with three replicates per treatment. The growth parameters measured included plant height, number of pods per plant, and number of grains per pod. Aphid populations and beneficial arthropod abundance (including spiders, coccinellids, syrphid flies, and mites) were monitored throughout the growing season.

4. Results:

The results showed that foliar application of 200 mg/L salicylic acid significantly improved plant growth, recording the highest plant height (250.13 cm), number of pods per plant (685.14), and grains per pod (26.8). Aphid populations were reduced by 93.8% to 200 mg/L, with the lowest reduction (1.5%) observed at 50 mg/L. Additionally, salicylic acid positively influenced the abundance of beneficial arthropods. Spider populations increased by 69.67%, coccinellids by 91.1%, syrphid flies by 87.12%, and mites by 5.1% at the highest concentration (200 mg/L).

5. Conclusion & Recommendations:

The study indicates that salicylic acid, particularly at a concentration of 200 mg/L, enhances canola plant growth and significantly reduces aphid populations while promoting beneficial arthropods. These findings suggest that salicylic acid can serve as an effective, sustainable tool for canola pest management, supporting both crop productivity and ecological balance. Further research is recommended to explore the long-term effects of salicylic acid applications and their integration into integrated pest management (IPM) strategies for canola.

Keywords: Canola, Salicylic Acid, Foliar Application, Aphids, Beneficial Arthropods, Pest Management

Evaluation of Salicylic Acid-Induced Changes in Aphid Species Dynamics in Wheat Crop

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1. Introduction:

Wheat (*Triticum aestivum*) is one of the most important staple crops globally and in Pakistan. However, aphids, particularly *Schizaphis graminum* (Hemiptera: Aphididae), pose a major threat to wheat yield and quality. Salicylic acid, a plant defense signaling molecule, has demonstrated potential in reducing pest infestations by enhancing plant resistance. This study evaluates the effects of varying concentrations of salicylic acid on aphid populations, wheat growth, and associated beneficial arthropods in field conditions.

2. Objectives:

The objective of this study was to assess the impact of different salicylic acid concentrations on aphid control, wheat growth, and the abundance of beneficial arthropods (spiders, coccinellids, syrphid flies, and mites) in wheat fields.

3. Methodology:

A field experiment was conducted at the Entomological Research Area using a randomized complete block design (RCBD). Five treatments with varying concentrations of salicylic acid (0, 50, 100, 150, and 200 mg/L) were applied as foliar sprays. Aphid populations and the abundance of beneficial arthropods were monitored, and wheat growth parameters, including grain weight, were recorded. Data were analyzed to assess the effects of salicylic acid on pest management and crop productivity.

4. Results:

The results showed that the highest concentration of salicylic acid (200 mg/L) significantly reduced aphid populations by 86.12%, while the lowest reduction (1.33%) was observed at 50 mg/L. The application of 200 mg/L also resulted in the highest attraction of beneficial arthropods: spiders increased by 228.57%, coccinellids by 1135.71%, syrphid flies by 482.3%, and mites by 14.45%. The maximum grain weight (47.51 g) was recorded at the 200 mg/L concentration, indicating improved crop yield. In comparison, lower concentrations showed less effective pest control and weaker beneficial arthropod attraction.

5. Conclusion & Recommendations:

The study indicates that foliar application of salicylic acid, particularly at 200 mg/L, effectively reduces aphid populations while promoting beneficial arthropods that contribute to natural pest control. This treatment also improves wheat yield, suggesting that salicylic acid can be integrated into sustainable pest management strategies for wheat production. Future studies should explore the long-term effects and optimal application methods of salicylic acid in field conditions, as well as its potential role in integrated pest management (IPM) for other crops.

Keywords: Wheat, Salicylic Acid, *Schizaphis graminum*, Arthropod Fauna, Foliar Application, Sustainable Pest Control

Effect of Nutritional Substrates on Mass Production and Virulence of Beauveria Bassiana against Fall Armyworm

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1. Introduction:

The fall armyworm (Spodoptera frugiperda) is a destructive invasive pest of maize and other crops, causing major yield losses. While synthetic insecticides are commonly used, they threaten the environment and biodiversity. This study evaluates how different solid substrates, rice, maize, and barley, affect the growth and pathogenicity of Beauveria bassiana against fall armyworm larvae.

2. Objectives:

The objective of this study was to assess how different nutritional substrates (rice, maize, and barley) affect the growth and pathogenicity of *B. bassiana* against various developmental stages of the fall armyworm. The study also aimed to determine the efficacy of different fungal concentrations in controlling larval infestation under laboratory and field conditions.

3. Methodology:

Beauveria bassiana was mass-produced on rice, maize, and barley. Five concentrations (1×10^5–1×10^9 cfu/mL) were tested on 2nd–5th instar fall armyworm larvae and pupae under laboratory conditions, with mortality recorded at 7, 14, 21, and 28 days. Field trials used the highest concentration (1×10^9 cfu/mL) for foliar application, assessing larval infestation after 45 days. Data were analyzed to evaluate effects of substrate and concentration on fungal efficacy.

4. Results:

Laboratory bioassays showed stage-specific mortality, with the 2nd instar exhibiting the highest mortality (43.33%) at 28 days post-treatment. The 3rd, 4th, and 5th instars showed 36.67%, 33.67%, and 28.33% mortality, respectively. Pupae were less susceptible, with a maximum mortality of 21.67% at 7 days post-exposure. In field conditions, the foliar application of the highest fungal concentration (1×10^9 cfu/mL) led to a 66.17% reduction in larval infestation after 45 days. The choice of nutritional substrate significantly influenced fungal efficacy, with *B. bassiana* grown on barley showing the highest efficacy, followed by maize and rice. These findings suggest that the nutritional substrate plays a critical role in optimizing fungal production for biocontrol applications.

6. Conclusion & Recommendations:

This study shows that Beauveria bassiana is an effective, eco-friendly biocontrol agent against fall armyworm. Nutritional substrate significantly influences fungal growth and pathogenicity, with barley being the most suitable for mass production. The findings support incorporating B. bassiana into integrated pest management as a sustainable alternative to chemical insecticides, with further research needed on production optimization and long-term field impact.

Keywords: *Beauveria bassiana*, Fall Armyworm, Nutritional Substrates, Pathogenicity, Biocontrol, Sustainable Pest Management

Keyword Index (Alphabetical, Unique)

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Anti-cramping
Anti-inflammatory
Anti-nutritional
Anti-tumor
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Ulaanbaatar
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Ultra-processed
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Valorize
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Valuation
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Value-added
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Vcgs

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Vegetable-producing
Vegetables
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Veterinary
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Victim
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Vinegar
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Violence
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Virus-infected
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Viscosity
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Vitamins
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Vocational
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Vulnerabilities
Vulnerability
Vulnerable

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Wages
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Waist-to-hip
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Walkability
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Waqf
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Wardah
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Warranting
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Water-intensive
Water-limited
Water-nutrient
Water-saving
Water-scarce
Water-use
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Well-known
Well-managed
Well-received
Well-structured
Well-suited
Wellness
Wellness-focused
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Wet
WFP
Wg-
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Wheat-based
Wheat-growing
White-collar
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Whole-grain
Whole-metagenome
Wholesome
WHR
Widely
Wider
Widespread
Wild
Wildlife
Willing
Willingness
Withania
Withdrawal
Women-friendly
Women-led
Workers
Workforce
Working
Working-age
Workload
Workplace
Workplaces
Workshops
Worldfish
Worldwide
Worm
Worms
Worsened
Worsening
Wounds
Wrinkles
WTP

X

Xiangyu

Y

Yield
Yield-determining
Yield-influencing
Yield-related
Yielded
Yields
Yogurt
Yogyakarta

Z

Zero-waste
Zhejiang
Zinc
Zingiber
Ziziphus
ZnO
Zoology
Zoonoses
Zoonotic

Themes

Sub-Theme	Explanation
Climate Resilience & Sustainable Resource Economics and Management	Focuses on economic tools and strategies to strengthen resilience against climate and environmental challenges. Includes adoption and impact assessment of climate-smart agriculture, optimization of the water-energy-food nexus (e.g., microplastics in agro-ecosystems), and mechanisms like carbon pricing, green innovation, and ecosystem service valuation.
Agri-Food System Transformation, Food Security & Market Dynamics	Examines changes in food systems under uncertainty and transformation. Topics include shifts in trade and value chains, resilience of digital agriculture platforms, competition policy, trade liberalization, and adaptations in food security strategies post-pandemic. Also explores behavioral economics of food, nutrition, and consumer decision-making.
Technology & Data-Driven Agriculture	Investigates the role of emerging technologies in agriculture. Covers artificial intelligence, remote sensing for precision farming, blockchain for traceability and ethical sourcing, and debates on ethical big data use. Emphasis on enhancing productivity, transparency, and smallholder inclusion through digital tools.
Equity, Policy & Institutional Innovation	Addresses inclusive policies and institutional reforms for equitable agri-food systems. Key areas include land tenure reform, gender equity, labor migration in rural economies, innovative subsidies, payments for ecosystem services (PES), multilateral governance, and integration of indigenous/community-led knowledge for adaptation.
Emerging Methodologies & Interdisciplinary Approaches	Encourages methodological innovations and cross-disciplinary collaboration. Includes life cycle assessment (LCA), circular bioeconomy modeling, sustainability metrics, as well as experimental and mixed-methods research that bridge economics, ecology, and social sciences for solving complex agri-food challenges.

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