The Agriculture Sector in Transition: Economic Contributions, Pollution Impact, Health effects, and Future Directions

Dr. A. Bharathi Reddy
Assistant Professor

Abstract- The agricultural sector plays a critical role in India's economy, contributing approximately 18-20% to the GDP and employing nearly 46% of the workforce. However, it also poses significant environmental and health challenges due to pollution from excessive chemical use, water over-extraction, and greenhouse gas emissions. This study aims to analyze the economic contributions of agriculture, the environmental impact of pollution, and the health risks associated with modern farming practices while exploring sustainable solutions for the sector's future. The findings, collected from both primary and secondary sources, highlight a growing public awareness of the harmful effects of chemical farming, with many individuals showing interest in sustainable alternatives like organic farming. The study concludes sustainability depends on transitioning toward eco-friendly practices, improving farmer livelihoods, and integrating technological innovations to enhance productivity while reducing environmental harm.

INTRODUCTION

The agriculture sector contributes 18–20% to India's GDP (FY 2022–23) and employs about 46% of the workforce. It spans 2,191 lakh hectares of land and uses 70–80% of the country's freshwater, much of which leads to pollution through runoff. It also accounts for 74% of methane and 18–20% of India's total greenhouse gas emissions. Despite its vital role in feeding the nation, the sector faces challenges like low productivity, climate variability, and reduced investment. While its GDP share has dropped from over 50% in the 1950s to around 15% today due to rapid industrial and service sector growth, its actual output has increased.

Features of the Research
- ❖ Comprehensive Scope: This research offers an in-depth exploration of multiple dimensions of the agricultural sector, focusing on both the challenges and opportunities it presents for sustainable development. The following areas are examined: Economic Contributions, Pollution Impact, Health Effects, and Future Directions.
- ❖ Data-Driven Analysis: This research is supported by reliable data collected from the Ministry of Agriculture, the Food and Agriculture Organization (FAO), the Intergovernmental Panel on Climate Change (IPCC), and other relevant institutions. The data provides empirical evidence for evaluating trends in agricultural output, environmental pollution levels, health statistics, and policy impacts.
- ❖ Interdisciplinary Approach: The research adopts from diverse fields such as economics, environmental science, public health, and sustainability studies. This way, it creates a holistic understanding of the agricultural sector's complexities and interconnections.
- ❖ Solution-Oriented: This study is focused on providing practical, actionable solutions to the challenges faced by the agricultural sector. It proposes specific measures to reduce pollution, address health risks, economic efficiency.
- ❖ Policy Implications: This research offers crucial policy recommendations aimed at improving agricultural sustainability, health, and economic performance. It provides evidence-based insights for policymakers, suggesting reforms in agricultural practices, environmental regulations, and public health management.

Functions of the Research:
- ❖ Informing Stakeholders
- • Government and Policymakers: *The research offers evidence-based recommendations to shape*

agricultural and environmental policies to achieve a sustainable and self-sufficient nation.

- Farmers: *The research highlights the adoption of sustainable farming techniques that can reduce harmful environmental and health impacts while increasing agricultural productivity*
- Public Health Authorities: *The research identifies health risks linked to modern agricultural practices, such as pesticide exposure, waterborne diseases, and air pollution from crop burning.*

❖ Educating and Raising Awareness

This study aims to raise awareness to general public about various problems in modern agriculture practices and also educate farmers.

❖ Exploring Sustainable Alternatives

➢ Identifying Traditional Agriculture Issues: *The research delves into the limitations and challenges associated with traditional agricultural methods, such as overuse of chemical fertilizers, water scarcity, soil erosion, and loss of biodiversity.*

➢ Proposing Innovative and Sustainable Practices: *To address the issues caused by traditional agriculture, the research proposes a range of sustainable alternatives that can enhance agricultural productivity while minimizing environmental harm such as organic farming, crop diversification etc.*

Objectives of the Research:
- To understand the contribution of agriculture sector towards Indian GDP.
- To bring awareness about health effects of chemical farming.
- To provide a basis for policy formulation regarding agriculture.
- To Provide strategic and sustainable, theory-based solution for agricultural.

Advantages of the research: This research will provide actionable recommendations for farmers, governments, and international organizations to reduce agriculture's environmental footprint and enhance climate resilience. It will examine agriculture's impact on greenhouse gas emissions, deforestation, water consumption, and pollution from fertilizers, pesticides, and waste burning, suggesting ways to promote sustainable practices.

Disadvantages of the research: This research faces several challenges, including its broad scope, which may dilute in-depth analysis in areas like economic policies or detailed environmental impacts. Implementing solutions may be hindered by local resistance, infrastructure limitations, or lack of government support, and unpredictable factors like climate change and technological advancements.

Primary Data: Primary data was collected through structured Google Forms surveys targeting farmers, agricultural experts, and policymakers. The questionnaire focused on the economic role of agriculture, pollution caused by farming practices, and related health effects in rural areas.

Secondary Data: Secondary data was sourced from credible publications, including academic journals, government reports, and documents from international organizations like the FAO and IPCC. Secondary data helped contextualize the primary findings, trace historical trends, and assess the effectiveness of existing policies.

Table 1	
Year	Contribution
1960-61	47.6%
1970-71	41.7%
1980-81	35.7%
1990-91	29.5%
2000-01	22.3%
2010-11	14.4%
2011-12	18.3%
2020-21	18.3%
2022-23	18.3%

Agriculture Sector in India

Agriculture remains the primary income source for over 70% of rural households in India, especially for smallholder farmers facing challenges like fragmented landholdings, low productivity, and climate vulnerability. Financial constraints, limited credit access, and dependence on informal lenders often trap farmers in debt, underscoring the need for equitable financing and sustainable income models. Climate change—through erratic rainfall and rising temperatures—further threatens yields, requiring investments in water management, drought-resistant crops, and climate-smart practices. Though agriculture's share in GDP declined from over 50% at independence to 18.2% in 2023, it continues to support

over 42% of the population and remains vital for food security and rural development. Recent years have seen a resurgence, with a 5.6% growth in 2024, aided by good monsoons, export growth, and government support. Technological advancements and agri-research, which yield high returns, offer pathways for sustainable growth. The sector's apparent GDP share decline is relative, as absolute output has grown substantially. To strengthen agriculture's role, strategic investments, policy reforms, and tech integration are essential. India can increase agriculture's contribution to GDP through several key strategies: Enhancing Productivity through Technology, Expanding Irrigation Facilities, and Encouraging Agri-Exports.

India-Specific Agricultural Solutions:
Utilizing Unused Land: Satellite mapping can reclaim unused land for agroforestry, integrated farming, and high-value crops. Flexible leasing, cooperative farming, and government incentives for soil rejuvenation and afforestation can boost land productivity.
Farmer Education: Strengthening Krishi Vigyan Kendras and digital tools (apps, WhatsApp, YouTube) can improve farmer training. Focus areas include organic farming, hydroponics, climate resilience, and government schemes, supported by workshops, field schools, and university tie-ups.
Successful State Strategies: Maharashtra uses drip irrigation; Punjab promotes mechanization; Haryana improves market access; Andhra Pradesh boosts exports; Rajasthan reclaims saline land; Tamil Nadu and UP expand credit access and modern practices..

Key Solutions to Reduce Pollution's Impact on Agriculture
- Sustainable Farming Techniques: Promote organic farming, crop rotation, bio-pesticides, and natural fertilizers (e.g., compost) to reduce chemical use and improve soil and water health.
- Control Stubble Burning: Encourage use of Happy Seeders and bio-decomposers to manage crop residue and reduce air pollution.
- Clean Energy Adoption: Use solar-powered irrigation systems to lower the carbon footprint of farming.
- Government Support: Provide incentives, financial aid, and awareness campaigns to support farmers in adopting eco-friendly practices.

Environmental & Health Impacts of Chemical Farming
- Water Contamination: Runoff pollutes rivers and groundwater with nitrates, causing methemoglobinemia (blue baby syndrome) and other health risks.
- Soil Degradation: Chemicals disrupt beneficial microbes, reducing fertility and increasing dependency on artificial inputs.
- Air Pollution & Climate Change: Fertilizers release nitrous oxide, a potent greenhouse gas, contributing to climate change.
- Biodiversity Loss: Monoculture practices harm pollinators and reduce native plant species.
- Human & Animal Health Risks: Farmers and consumers face risks like cancer, respiratory issues, and hormonal imbalances from pesticide exposure. Livestock suffer too, impacting the food chain.

Incident	Location	Year	Pesticides Involved	Impact on Drinking Water and Health
Eluru Outbreak	Eluru, Andhra Pradesh, India	2020	Organophosphates (e.g., Triazofos)	Sudden illness affected over 450 residents; pesticide residues in drinking water were a probable cause.
Endosulfan Tragedy	Kasaragod, Kerala, India	1978–2001	Endosulfan	Aerial spraying contaminated water sources; led to congenital anomalies, cancers, and neurological disorders.
Chlorothalonil Contamination	Switzerland	2019	Chlorothalonil	Fungicide metabolites found in groundwater; raised drinking water safety concerns and legal restrictions on information.
TFA Contamination	France	2024	Trifluoroacetic acid (TFA)	Persistent chemical found in drinking water; poses compliance and potential health risks.

Sustainable Alternative: Organic Farming

Organic farming avoids synthetic chemicals, using composting, crop rotation, and biological pest control to boost soil health, conserve water, and protect biodiversity. It offers fair pricing through certification and market access, promoting eco-friendly livelihoods. Government support through subsidies, loans, and rural infrastructure can aid the transition.

Challenges

Initial yields are often lower due to the time needed to restore soil health. High transition costs, limited market access, and lack of infrastructure and knowledge deter small farmers.

Path to Sustainable Farming in India

A holistic approach blending traditional knowledge with modern tech is key. Promoting organic practices, crop diversification, and water-efficient methods like drip irrigation can reduce environmental impact and improve resilience. Policy support, biofertilizers, climate-resilient crops, and better infrastructure are vital. With education, financing, and tech tools, India can empower farmers and ensure sustainable agriculture.

Data Analysis & Data Interpretation

1. Used Artificial Chemicals

Option	Yes	No	I have never planted a tree
Respondents	11	18	2
Percentage	35.5	58.1	6.5

2.Did you use any artificial pesticides, insecticides, or fertilizer on the plant/tree.
31 responses

Data interpretation: The analysis of the given data shows that a majority of respondents, 18 (58.1%), answered 'No,' indicating that they have not used artificial pesticides, insecticides, or fertilizers on plants or trees. This suggests a preference for natural or organic growing methods among most respondents. On the other hand, 11 respondents (35.5%) admitted to using artificial chemicals, which implies that a significant portion still relies on conventional farming

or gardening practices. Additionally, 2 respondents (6.5%) stated that they have never planted a tree, indicating a lack of direct experience with cultivation.

2. Do you agree on the statement, "Agriculture sector is a major contributor towards Indian GDP"

Option	Agree	Disagree	Not sure
Respondents	22	2	7
Percentage	71	6.5	22.6

3.Do you agree on the statement, "Agriculture sector is a major contributor towards Indian GDP"
31 responses

Data interpretation: The analysis of the given data indicates that a majority of respondents, 22 (71%), agree that the agriculture sector is a major contributor to India's GDP, reflecting a strong awareness of the sector's economic significance. Meanwhile, 7 respondents (22.6%) selected 'Not sure,' suggesting some level of uncertainty or lack of knowledge about agriculture's role in the country's economy. A small portion, 2 respondents (6.5%), disagreed, indicating a differing perspective or possible belief that other sectors contribute more significantly.

3. Did you know that most farmers are severely under paid for their crops?

Option	Yes	No
Respondents	26	5
Percentage	83.9	16.1

10.Did you know that most farmers are severely under paid for their crops
31 responses
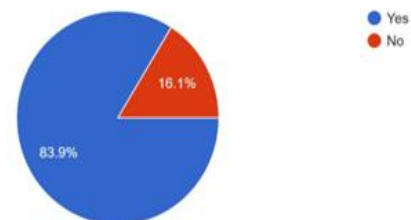
Data interpretation: The analysis of the given data shows that a majority of respondents, 26 (83.9%), answered 'Yes,' indicating awareness that most farmers are severely underpaid for their crops. Meanwhile, 5 respondents (16.1%) selected 'No,'

suggesting a lack of awareness among a small portion of the group. This data highlights the general recognition of the financial struggles faced by farmers, emphasizing the need for fair pricing policies and better support systems for the agricultural community.

4. Do you agree that the policies framed by the Indian government are favorable to the farmers? (Some policies are Prime Minister Matsya Sampada Yojana, PM- KUSUM Scheme - Sub-Mission on Agricultural Mechanization (SMAM), Kisan Credit Card Scheme, etc)

Option	1 (not concerned)	2	3(neutral)	4	5(highly concerned)
Respondents	1	2	8	5	15
percentage	3.2	6.5	25.8	16.1	48.4

11.Do you agree that the policies framed by the Indian government are favourable to the farmers. (Some policies are Prime Minister Matsya Sampada...t Card Scheme* - *Soil Health Card Scheme*, etc)
31 responses
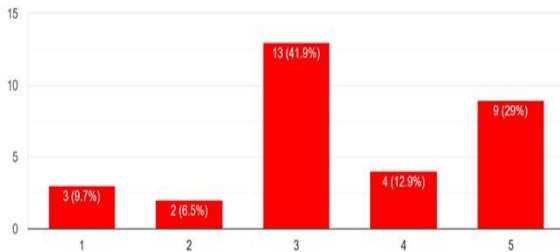
Data interpretation: *The analysis of the given data reveals diverse opinions on whether the policies framed by the Indian government are favorable to farmers. A significant portion of respondents, 13 (41.9%), remained neutral, indicating uncertainty or mixed views on the effectiveness of these policies. Meanwhile, 9 respondents (29%) rated them as highly favorable, and 4 respondents (12.9%) found them somewhat favourable. On the other hand, 3 respondents (9.7%) believed the policies were not favorable, while 2 respondents (6.5%) rated them slightly unfavorable.*

5. Are you concerned about the health impacts of pesticide residues in food?

Option	1 (not favorable)	2	3 (neutral)	4	5 (highly favorable)
Respondents	3	2	13	4	9
Percentage	9.7	6.5	41.9	12.9	29

13.Are you concerned about the health impacts of pesticide residues in food?
31 responses
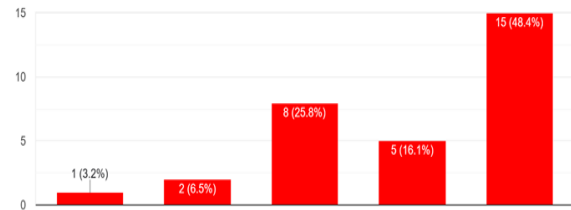
Data interpretation: *The analysis of the given data reveals that a majority of respondents, 15 (48.4%), are highly concerned about the health impacts of pesticide residues in food. Additionally, 5 respondents (16.1%) expressed concern, further indicating widespread awareness of potential health risks. On the other hand, 8 respondents (25.8%) remained neutral, suggesting some level of uncertainty or a lack of strong opinion on the matter. A small proportion, 2 respondents (6.5%), showed minimal concern, while only 1 respondent (3.2%) was not concerned at all.*

CONCLUSION

The study underscores the harmful effects of excessive chemical use, soil and water pollution, and greenhouse gas emissions caused by agricultural activities. The health risks associated with chemical farming ranging from pesticide exposure to water contamination call for urgent reforms. Additionally, climate change-induced disruptions, such as erratic rainfall and rising temperatures, further threaten agricultural productivity.

However, the future of Indian agriculture is not bleak. Transitioning to sustainable practices such as organic farming, precision agriculture, and agro-forestry can help mitigate environmental damage while maintaining productivity. Government policies, farmer education, and technological advancements can play a crucial role in this transformation. The adoption of climate-smart techniques and efficient resource management will be vital in ensuring the sector's resilience. To achieve a balance between economic growth, environmental sustainability, and public health, a collective effort is required. Policymakers, farmers, industries, and consumers must work together to implement solutions that promote sustainability without compromising food security. The path forward lies in integrating modern technology with traditional wisdom to build a more sustainable and resilient agricultural sector.