International Journal of Advanced Research and Multidisciplinary Trends (IJARMT)
An International Open Access, Peer-Reviewed Refereed Journal
Impact Factor: 7.2 Website: https://ijarmt.com ISSN No.: 3048-9458

Influence of Agricultural Technology Adoption on Sustainable Agricultural Development in Chopra Tehsil, Uttar Dinajpur District, West Bengal

Dr.Reshmi Sarkar
Assistant Teacher , Department of Geography,Hili Girls high school ,Village Chamundatala, P.O. & P.S. Hili, District Dakshin Dinajpur, West Bengal.
Email ID -reshmisarkar830@gmail.com

Abstract
Agriculture remains the principal source of livelihood in Chopra Tehsil of Uttar Dinajpur District, West Bengal. The increasing demand for food security, environmental protection, and economic sustainability has intensified the need for technological innovations in agriculture. The present study investigates the influence of agricultural technology adoption on sustainable agricultural development in the study area. A qualitative research approach was employed, and primary data were collected from 251 farmers through interviews, discussions, and field observations. The study examined the level of technology adoption, perceived benefits, challenges, and the overall contribution of agricultural technologies toward sustainability. The findings revealed that 59.76% of respondents exhibited high to very high levels of agricultural technology adoption. Increased crop productivity (29.48%) emerged as the most significant benefit, followed by improved farm income (24.70%). High initial investment costs (27.49%) and limited access to credit facilities (23.11%) were identified as the major barriers. Furthermore, 66.53% of respondents perceived a high or very high impact of technology adoption on sustainable agricultural development. The study concludes that technological interventions significantly contribute to productivity enhancement, efficient resource utilization, environmental sustainability, and rural livelihood improvement. Policy measures focusing on training, extension services, and financial support are essential for accelerating sustainable agricultural development in Chopra Tehsil.

Keywords: Agricultural Technology Adoption, Sustainable Agricultural Development, Farmers, Innovation, Rural Development, West Bengal.

Introduction

Agriculture has historically served as the backbone of the Indian economy, providing livelihood opportunities to a substantial proportion of the rural population while ensuring national food security and socio-economic stability. Despite rapid industrialization and urbanization, agriculture continues to occupy a central position in India's developmental framework. According to the Food and Agriculture Organization (FAO), sustainable agricultural growth is essential for achieving food security, reducing poverty, and ensuring environmental sustainability in developing countries (FAO, 2023). In this context, technological innovation has emerged as a crucial instrument for enhancing agricultural productivity, improving resource-use efficiency, and promoting sustainable rural development. The concept of sustainable agricultural development gained prominence following growing concerns regarding environmental degradation, declining soil fertility, depletion of water resources, biodiversity loss, and climate change. Sustainable agricultural development refers

International Journal of Advanced Research and Multidisciplinary Trends (IJARMT)
An International Open Access, Peer-Reviewed Refereed Journal
Impact Factor: 7.2 Website: https://ijarmt.com ISSN No.: 3048-9458

to a system of agricultural production that satisfies present food and fiber requirements while preserving ecological integrity and maintaining the productive capacity of natural resources for future generations (Pretty, 2018). It seeks to establish a balance between economic profitability, environmental conservation, and social equity, thereby ensuring long-term agricultural viability.

In recent decades, agricultural technology adoption has become an important strategy for achieving sustainable agricultural development. Agricultural technologies encompass a wide range of innovations, including improved seed varieties, mechanization, precision farming techniques, information and communication technologies (ICTs), modern irrigation systems, soil testing methods, integrated pest management practices, and digital advisory services. These technologies facilitate scientific decision-making, enhance production efficiency, minimize input wastage, and improve resilience against environmental uncertainties. Consequently, technology adoption has been recognized as a key driver of agricultural transformation across both developed and developing economies (World Bank, 2022).

The diffusion of agricultural technologies among farmers is frequently explained through Rogers' Diffusion of Innovation Theory, which suggests that the adoption of innovations depends upon factors such as relative advantage, compatibility, complexity, trialability, and observability (Rogers, 2003). Farmers tend to adopt technologies when they perceive clear economic benefits, ease of implementation, and compatibility with existing farming systems. The successful diffusion of agricultural innovations therefore depends not only on technological effectiveness but also on socio-economic, institutional, and cultural factors influencing farmers' decision-making processes.

India's agricultural sector has witnessed significant technological advancements since the Green Revolution of the 1960s. The introduction of high-yielding varieties, chemical fertilizers, pesticides, and irrigation infrastructure substantially increased food grain production and transformed the agricultural landscape. However, concerns have subsequently emerged regarding the ecological consequences of intensive agricultural practices, including groundwater depletion, soil degradation, and environmental pollution. These challenges have intensified the need for sustainable agricultural technologies that enhance productivity without compromising environmental quality (Government of India, 2024).

Contemporary agricultural technologies focus on improving productivity while simultaneously promoting environmental sustainability. Improved seed varieties offer higher yields, disease resistance, and climate adaptability. Mechanization reduces labor requirements and increases operational efficiency. Precision agriculture facilitates site-specific management of agricultural inputs, thereby reducing resource wastage. Modern irrigation technologies such as drip and sprinkler systems enhance water-use efficiency and contribute to sustainable water management. Digital agricultural advisory platforms provide real-time information regarding weather conditions, pest outbreaks, market prices, and crop management practices, enabling farmers to make informed decisions (FAO, 2023).

The significance of agricultural technology adoption is particularly evident in regions characterized by smallholder farming systems. Small and marginal farmers frequently

encounter challenges related to limited land resources, inadequate access to credit, fluctuating market conditions, and vulnerability to climate change. Technological innovations can assist such farmers in overcoming production constraints, increasing agricultural income, and improving livelihood security. Research has consistently demonstrated positive relationships between technology adoption and agricultural productivity, income enhancement, and sustainability outcomes (Singh & Kumar, 2021).

West Bengal represents one of India's agriculturally important states, characterized by diverse agro-climatic conditions and intensive cultivation practices. Agriculture contributes substantially to rural employment and economic development within the state. The state has achieved notable success in crop production through the adoption of modern agricultural technologies and institutional reforms. Nevertheless, regional disparities persist in terms of technological access, infrastructure availability, and agricultural productivity. Understanding these disparities is essential for designing effective agricultural development strategies.

Uttar Dinajpur District, situated in the northern part of West Bengal, possesses significant agricultural potential owing to its fertile alluvial soils, favorable climatic conditions, and extensive cultivation activities. Agriculture serves as the primary source of livelihood for a majority of the district's population. Major crops cultivated in the district include paddy, wheat, maize, jute, mustard, and various horticultural crops. Despite favorable natural conditions, farmers continue to face numerous challenges related to technological accessibility, market integration, infrastructure development, and climate variability.

Chopra Tehsil, one of the important administrative units within Uttar Dinajpur District, exhibits a predominantly agrarian socio-economic structure. The agricultural economy of Chopra is characterized by a large concentration of small and medium-scale farmers who depend heavily on farming for household income and livelihood sustenance. The increasing pressure on agricultural resources, combined with changing climatic conditions, necessitates the adoption of sustainable farming practices and technological innovations capable of enhancing productivity while preserving environmental quality.

The adoption of agricultural technologies within Chopra Tehsil has gradually increased in recent years. Farmers have increasingly embraced improved seed varieties, mechanized cultivation practices, scientific nutrient management techniques, and digital agricultural information services. Government initiatives, extension programs, and agricultural development schemes have contributed to this process by promoting awareness and facilitating access to technological resources. However, significant challenges continue to hinder widespread technology adoption, including financial limitations, inadequate technical knowledge, insufficient extension support, and infrastructural deficiencies.

One of the most critical barriers affecting technology adoption among farmers is the high initial investment required for purchasing agricultural machinery, installing irrigation systems, and acquiring improved agricultural inputs. Smallholder farmers often face financial constraints that limit their capacity to invest in advanced technologies. Limited access to institutional credit further exacerbates these challenges, preventing farmers from realizing the full benefits of

technological innovation. Consequently, understanding the nature and magnitude of these barriers is essential for developing effective intervention strategies.

Another important factor influencing technology adoption is the availability of agricultural knowledge and extension services. Farmers require technical information regarding the operation, maintenance, and benefits of agricultural technologies. Extension agencies play a crucial role in facilitating technology transfer through training programs, demonstrations, and advisory services. Inadequate extension support can significantly reduce adoption rates and impede sustainable agricultural development. Therefore, strengthening institutional mechanisms for knowledge dissemination remains a critical priority.

The relationship between agricultural technology adoption and sustainable agricultural development extends beyond productivity enhancement. Technological innovations contribute to sustainability by improving resource-use efficiency, reducing environmental degradation, conserving water resources, enhancing soil health, and promoting climate resilience. For instance, precision irrigation systems reduce water wastage, while integrated nutrient management practices improve soil fertility and minimize environmental contamination. Similarly, digital advisory services assist farmers in optimizing agricultural operations and reducing production risks.

Climate change has further increased the importance of agricultural technology adoption. Rising temperatures, changing rainfall patterns, extreme weather events, and increasing pest infestations pose significant challenges to agricultural sustainability. Climate-smart agricultural technologies provide adaptive solutions that enhance resilience and reduce vulnerability to environmental shocks. Consequently, technology adoption has become a fundamental component of sustainable agricultural development strategies worldwide (UNDP, 2022).

The Sustainable Development Goals (SDGs), particularly Goal 2 (Zero Hunger), Goal 12 (Responsible Consumption and Production), and Goal 13 (Climate Action), emphasize the importance of sustainable agricultural practices and technological innovation in achieving global development objectives. Agricultural technologies contribute directly to these goals by increasing food production, improving resource efficiency, reducing environmental impacts, and strengthening rural livelihoods. Therefore, examining the influence of technology adoption on agricultural sustainability is highly relevant within contemporary development discourse.

Although numerous studies have investigated agricultural technology adoption in various regions of India, limited empirical evidence is available regarding its specific influence on sustainable agricultural development in Chopra Tehsil, Uttar Dinajpur District, West Bengal. Given the region's unique socio-economic and agro-ecological characteristics, localized research is necessary to understand the opportunities and challenges associated with technological transformation. Such knowledge can assist policymakers, development agencies, and agricultural institutions in formulating context-specific strategies for promoting sustainable agricultural development.

The present study addresses this research gap by examining the level of agricultural technology adoption among farmers in Chopra Tehsil and evaluating its contribution to sustainable

International Journal of Advanced Research and Multidisciplinary Trends (IJARMT)
An International Open Access, Peer-Reviewed Refereed Journal
Impact Factor: 7.2 Website: https://ijarmt.com ISSN No.: 3048-9458

agricultural development. The study also explores the perceived benefits and challenges associated with technology adoption while assessing its overall impact on economic, environmental, and social dimensions of sustainability. By generating empirical evidence regarding the role of technological innovation in agricultural transformation, the study contributes to the broader understanding of sustainable rural development and agricultural modernization.

In conclusion, agricultural technology adoption represents a critical pathway toward achieving sustainable agricultural development in contemporary rural economies. The integration of technological innovations into farming systems has the potential to enhance productivity, improve income levels, optimize resource utilization, strengthen environmental sustainability, and increase resilience against climate-related risks. Given the strategic importance of agriculture within Chopra Tehsil, understanding the dynamics of technology adoption is essential for promoting sustainable development and improving the well-being of farming communities. The findings of this study are expected to provide valuable insights for researchers, policymakers, extension professionals, and development practitioners seeking to advance sustainable agricultural development in the region and beyond.

Review of Literature

Rogers (2003) emphasized that innovation adoption is influenced by perceived advantages, compatibility, complexity, trialability, and observability. Farmers are more likely to adopt technologies that demonstrate clear economic and environmental benefits.

Pretty (2018) argued that sustainable intensification through technological innovations enhances agricultural productivity while minimizing environmental degradation. Modern technologies improve resource-use efficiency and reduce dependency on chemical inputs.

Das and Ghosh (2022) found that technological adoption significantly increased crop productivity and household income among farmers in eastern India. The study highlighted the importance of extension services and training programs.

Sharma and Patel (2020) reported that agricultural technologies contribute to environmental sustainability by reducing water consumption, improving nutrient management, and minimizing soil degradation.

Mukherjee (2023) observed that agricultural modernization in West Bengal has improved farm productivity; however, challenges related to financial constraints and inadequate technical knowledge continue to limit adoption among small farmers.

Bhattacharya (2024) examined the relationship between sustainable farming practices and technological advancement in West Bengal. The study reported that farmers adopting modern agricultural technologies, including improved seed varieties, mechanized equipment, and scientific nutrient management practices, achieved significantly higher crop productivity and income levels. The research further highlighted that technology adoption contributed to efficient resource utilization and environmental conservation. However, inadequate financial support and limited technical knowledge remained major barriers to widespread adoption.

The Ministry of Agriculture and Farmers Welfare (2024) reported a substantial increase in the adoption of digital agriculture, precision farming, mechanization, and climate-resilient

technologies across India. The report emphasized that technological innovations have improved agricultural productivity, reduced production risks, and enhanced sustainability outcomes. Furthermore, government initiatives promoting digital advisory services and smart farming practices have strengthened farmers' access to agricultural information and improved decision-making processes.

The Food and Agriculture Organization (2023) highlighted the crucial role of agricultural technologies in achieving food security and sustainable development. The report emphasized that modern technologies such as precision agriculture, climate-smart farming, remote sensing, and digital extension services significantly enhance productivity while minimizing environmental degradation. The study concluded that technological innovation is essential for addressing climate change challenges and ensuring long-term agricultural sustainability.

Sen and Dasgupta (2023) investigated agricultural transformation and technology adoption among farmers in eastern India. The findings revealed that farmers utilizing modern agricultural technologies experienced higher productivity, improved market integration, and better resource management compared to non-adopters. The study also found that technological adoption strengthened climate resilience and contributed significantly to sustainable agricultural development. The authors recommended strengthening extension services and institutional support to accelerate technology diffusion among rural farmers.

Summary of Literature

The latest literature indicates that agricultural technology adoption has emerged as a significant driver of sustainable agricultural development. Recent studies consistently demonstrate positive impacts on productivity enhancement, income generation, resource-use efficiency, environmental sustainability, and climate resilience. Nevertheless, financial constraints, inadequate technical expertise, and limited institutional support continue to restrict widespread adoption among farming communities. These findings provide a strong foundation for examining the influence of agricultural technology adoption on sustainable agricultural development in Chopra Tehsil, Uttar Dinajpur District, West Bengal.

Objectives of the Study

1. To examine the level of agricultural technology adoption among farmers in Chopra Tehsil.
2. To identify the perceived benefits of agricultural technology adoption.
3. To analyze the challenges faced by farmers in adopting agricultural technologies.
4. To evaluate the impact of agricultural technology adoption on sustainable agricultural development.

Research Methodology

The study adopted a qualitative research design. Primary data were collected from 251 farmers selected through purposive sampling. Semi-structured interviews, field observations, and group discussions were employed to obtain detailed information regarding technology adoption and sustainability practices. The collected data were analyzed using percentage analysis and thematic interpretation.

International Journal of Advanced Research and Multidisciplinary Trends (IJARMT)
An International Open Access, Peer-Reviewed Refereed Journal
Impact Factor: 7.2 Website: https://ijarmt.com ISSN No.: 3048-9458

Results and Discussion

Table 1. Demographic Characteristics of Respondents.

S.N.	Particulars	Respondents	Percentage
1	Small Farmers	126	50.20
2	Medium Farmers	78	31.08
3	Large Farmers	47	18.72
Total		**251**	**100.00**

Interpretation

The demographic composition of the respondents demonstrates a predominance of small-scale agricultural holdings within the study area. Out of the total 251 respondents, 126 farmers (50.20%) belonged to the small farmer category, indicating that more than half of the agricultural population operates on relatively limited land resources. Medium farmers accounted for 78 respondents (31.08%), whereas large farmers constituted only 47 respondents (18.72%). The percentage distribution reveals a decreasing trend with increasing farm size, suggesting a fragmented agrarian structure characteristic of eastern Indian agriculture.

From a sustainability perspective, the dominance of small farmers has significant implications for agricultural development planning. Smallholders often exhibit greater dependence on agricultural income and are more vulnerable to climatic fluctuations, market uncertainties, and technological constraints. Consequently, targeted technological interventions among this group can generate substantial improvements in productivity and livelihood security. The statistical pattern further indicates that sustainable agricultural development strategies should prioritize resource-efficient technologies, capacity-building initiatives, and institutional support mechanisms tailored to small and medium farmers. The demographic structure therefore provides an important foundation for understanding technology adoption behavior and sustainability outcomes in Chopra Tehsil.

International Journal of Advanced Research and Multidisciplinary Trends (IJARMT)
An International Open Access, Peer-Reviewed Refereed Journal
Impact Factor: 7.2 Website: https://ijarmt.com ISSN No.: 3048-9458

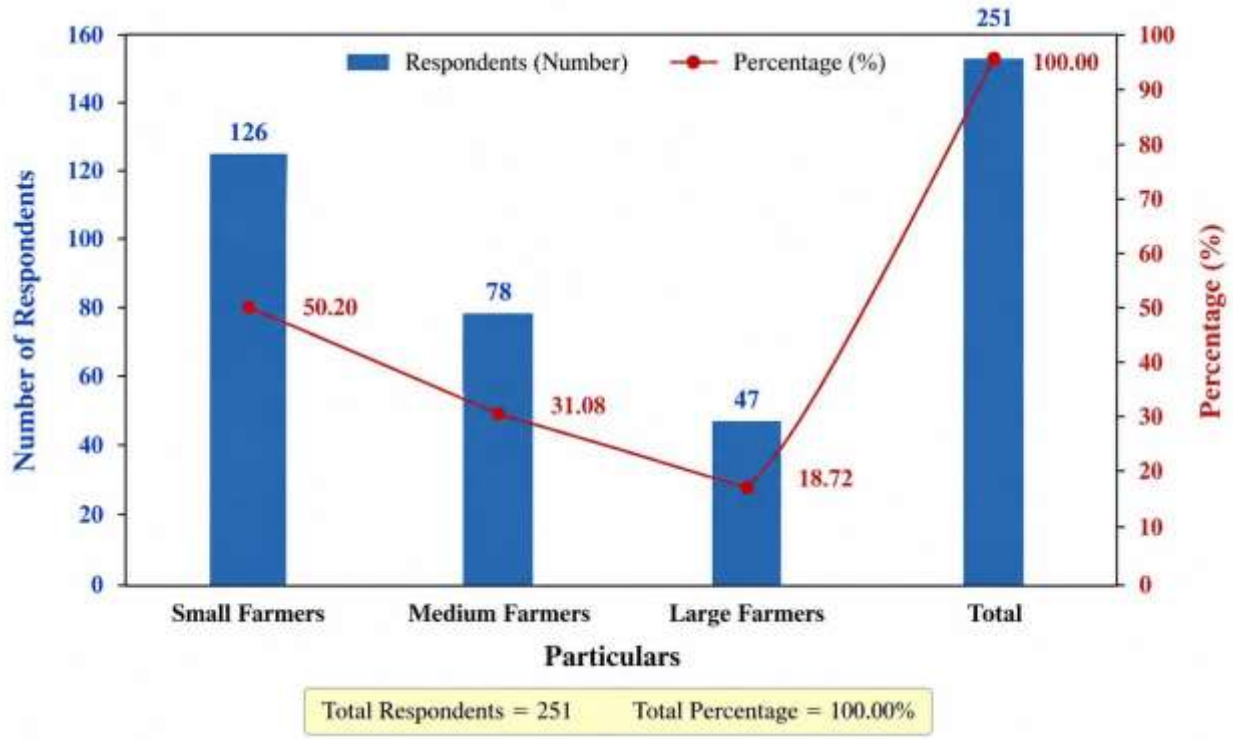


Table 2. Level of Agricultural Technology Adoption.

S.N.	Particulars	Respondents	Percentage
1	Very High Adoption	68	27.09
2	High Adoption	82	32.67
3	Moderate Adoption	56	22.31
4	Low Adoption	29	11.55
5	Very Low Adoption	16	6.37
Total		**251**	**100.00**

Interpretation

The distribution of agricultural technology adoption levels demonstrates a generally favorable inclination toward technological innovation among farmers. A total of 82 respondents (32.67%) reported a high level of adoption, while 68 respondents (27.09%) indicated a very high level. Collectively, these categories comprise 150 respondents, representing 59.76% of the sample population. In contrast, only 45 respondents (17.92%) reported low or very low levels of adoption.

The statistical distribution suggests that a majority of farmers recognize the utility and effectiveness of modern agricultural technologies. The moderate adoption category, accounting for 22.31% of respondents, represents a transitional segment with considerable potential for future technological advancement. The observed adoption pattern reflects increasing awareness regarding improved seeds, mechanization, digital agricultural services, and scientific farming techniques.

International Journal of Advanced Research and Multidisciplinary Trends (IJARMT)
An International Open Access, Peer-Reviewed Refereed Journal
Impact Factor: 7.2 Website: https://ijarmt.com ISSN No.: 3048-9458

From a technical standpoint, higher adoption levels are associated with enhanced production efficiency, optimization of input utilization, and improved resilience against environmental uncertainties. The substantial concentration of respondents within the high and very high adoption categories signifies an ongoing agricultural transformation process in the study area. Consequently, technology diffusion can be considered a critical determinant of sustainable agricultural development within Chopra Tehsil.

Fig. 2. Level of Agricultural Technology Adoption

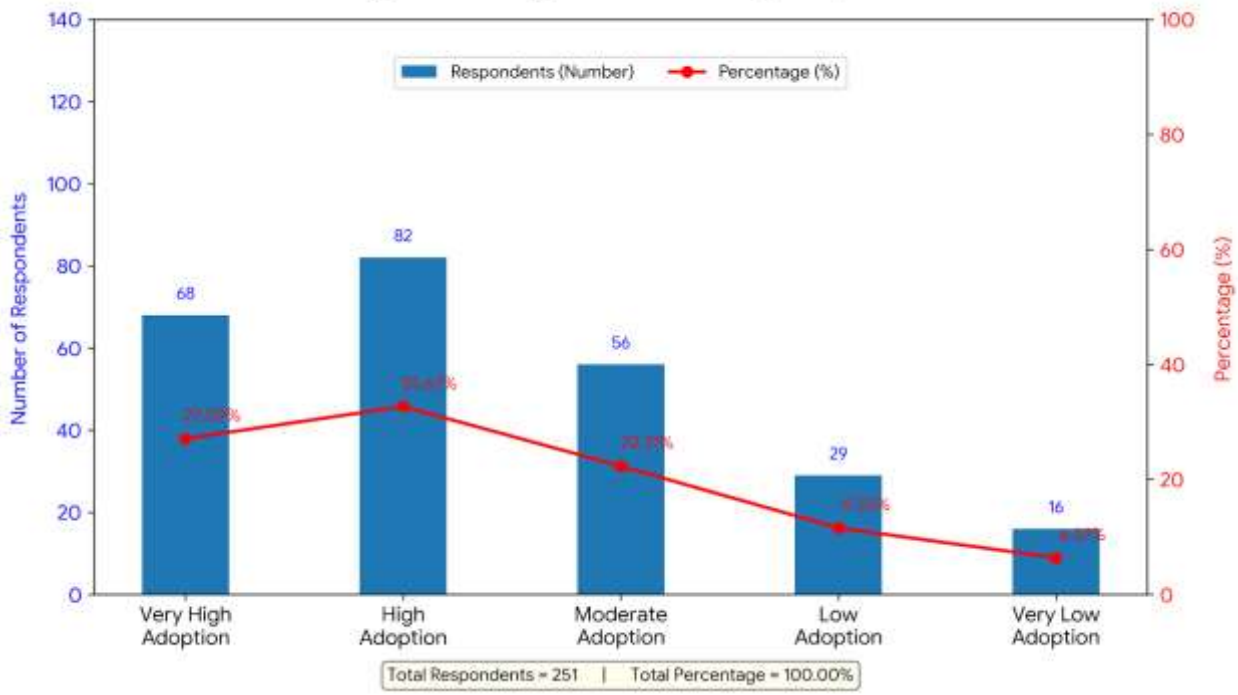


Table 3. Major Benefit Experienced from Agricultural Technology Adoption.

S.N.	Particulars	Respondents	Percentage
1	Increased Crop Productivity	74	29.48
2	Improved Farm Income	62	24.70
3	Efficient Resource Utilization	48	19.12
4	Reduced Production Cost	39	15.54
5	Environmental Sustainability	28	11.16
Total		**251**	**100.00**

Interpretation

International Journal of Advanced Research and Multidisciplinary Trends (IJARMT)
An International Open Access, Peer-Reviewed Refereed Journal
Impact Factor: 7.2 Website: https://ijarmt.com ISSN No.: 3048-9458

The findings reveal that increased crop productivity was identified as the most significant benefit by 74 respondents (29.48%). Improved farm income ranked second, reported by 62 respondents (24.70%). Efficient resource utilization was acknowledged by 48 respondents (19.12%), while reduced production costs and environmental sustainability were reported by 39 (15.54%) and 28 respondents (11.16%), respectively.

The statistical distribution indicates that productivity enhancement remains the primary motivation for technology adoption among farmers. The difference of 4.78 percentage points between crop productivity and improved farm income suggests that respondents perceive productivity gains as a precursor to economic improvement. Furthermore, the combined contribution of resource efficiency and environmental sustainability accounts for 30.28% of responses, highlighting growing awareness regarding sustainable farming principles.

Technically, these results demonstrate that agricultural technologies generate multidimensional benefits encompassing economic, environmental, and operational dimensions. Improved productivity enhances food security, while efficient resource utilization contributes to long-term sustainability through reduced wastage of water, fertilizers, and energy resources. The findings therefore confirm that agricultural technology adoption functions as a catalyst for both economic advancement and environmental stewardship.

Fig. 3. Major Benefit Experienced from Agricultural Technology Adoption

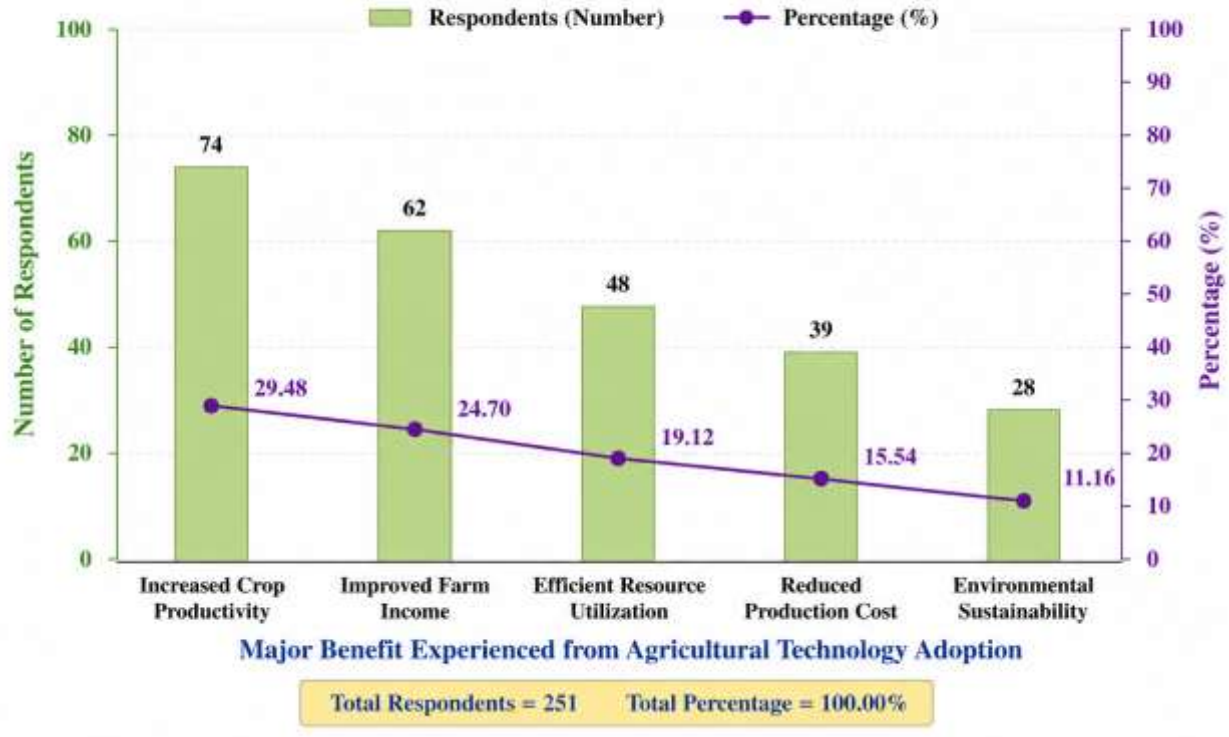


Table 4. Major Challenges in Agricultural Technology Adoption.

S.N.	Particulars	Respondents	Percentage
1	High Initial Cost	69	27.49

International Journal of Advanced Research and Multidisciplinary Trends (IJARMT)
An International Open Access, Peer-Reviewed Refereed Journal
Impact Factor: 7.2 Website: https://ijarmt.com ISSN No.: 3048-9458

2	Limited Access to Credit	58	23.11
3	Lack of Technical Knowledge	51	20.32
4	Poor Extension Services	42	16.73
5	Inadequate Government Support	31	12.35
Total		**251**	**100.00**

Interpretation

The results identify high initial cost as the most prominent challenge, reported by 69 respondents (27.49%). Limited access to agricultural credit was identified by 58 respondents (23.11%), while lack of technical knowledge affected 51 respondents (20.32%). Poor extension services and inadequate government support were reported by 42 (16.73%) and 31 respondents (12.35%), respectively.

The statistical pattern demonstrates that financial barriers collectively account for 50.60% of the total responses when high initial costs and limited credit access are considered together. This finding indicates that economic constraints constitute the principal obstacle to technological modernization within the agricultural sector. Knowledge-related barriers also remain significant, as over one-fifth of respondents reported inadequate technical expertise.

From a technical perspective, the existence of these constraints can significantly reduce technology diffusion rates and limit the realization of sustainability benefits. Inadequate access to financial capital restricts investment in advanced technologies, while insufficient knowledge impedes effective utilization of available innovations. The findings therefore emphasize the necessity of integrated policy interventions combining financial assistance, extension services, technical training, and institutional support to facilitate widespread technology adoption.

International Journal of Advanced Research and Multidisciplinary Trends (IJARMT)
An International Open Access, Peer-Reviewed Refereed Journal
Impact Factor: 7.2 Website: https://ijarmt.com ISSN No.: 3048-9458

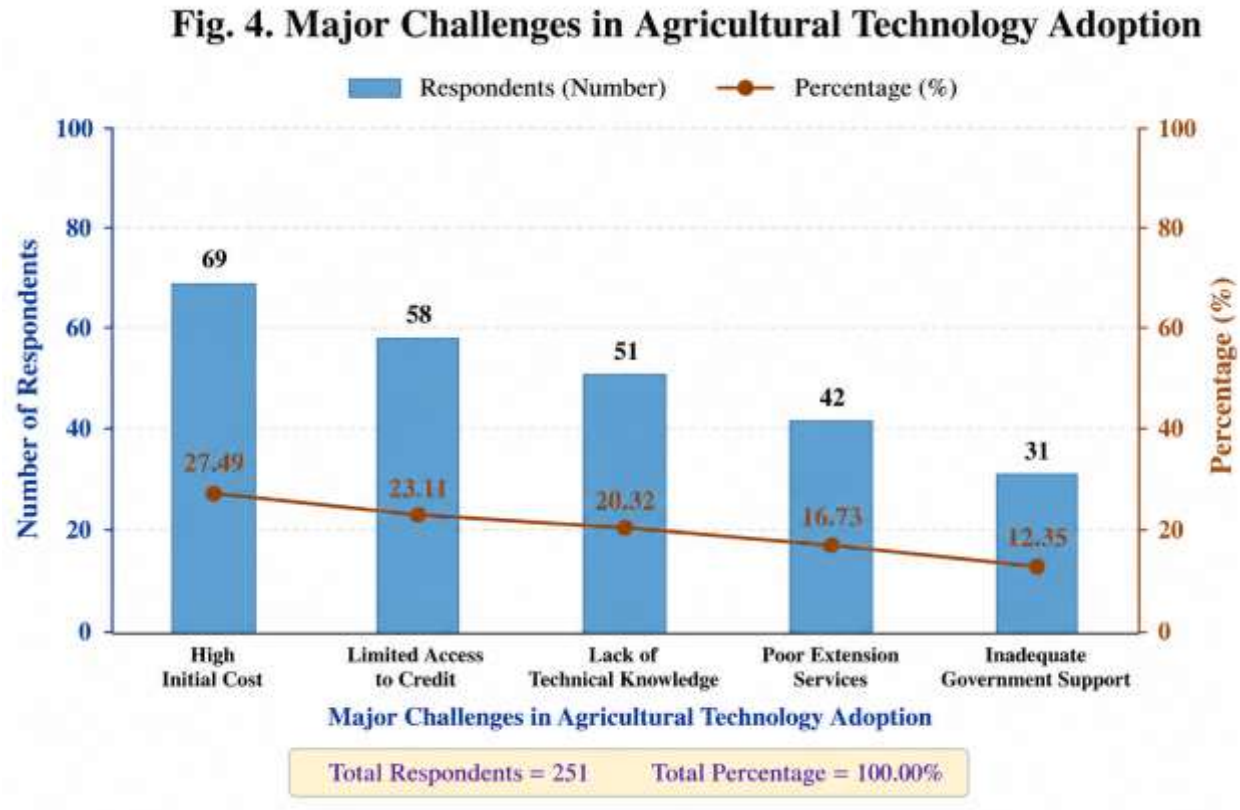


Table 5. Impact of Agricultural Technology Adoption on Sustainable Agricultural Development.

S.N.	Particulars	Respondents	Percentage
1	Very High Impact	79	31.47
2	High Impact	88	35.06
3	Moderate Impact	46	18.33
4	Low Impact	24	9.56
5	Very Low Impact	14	5.58
Total		**251**	**100.00**

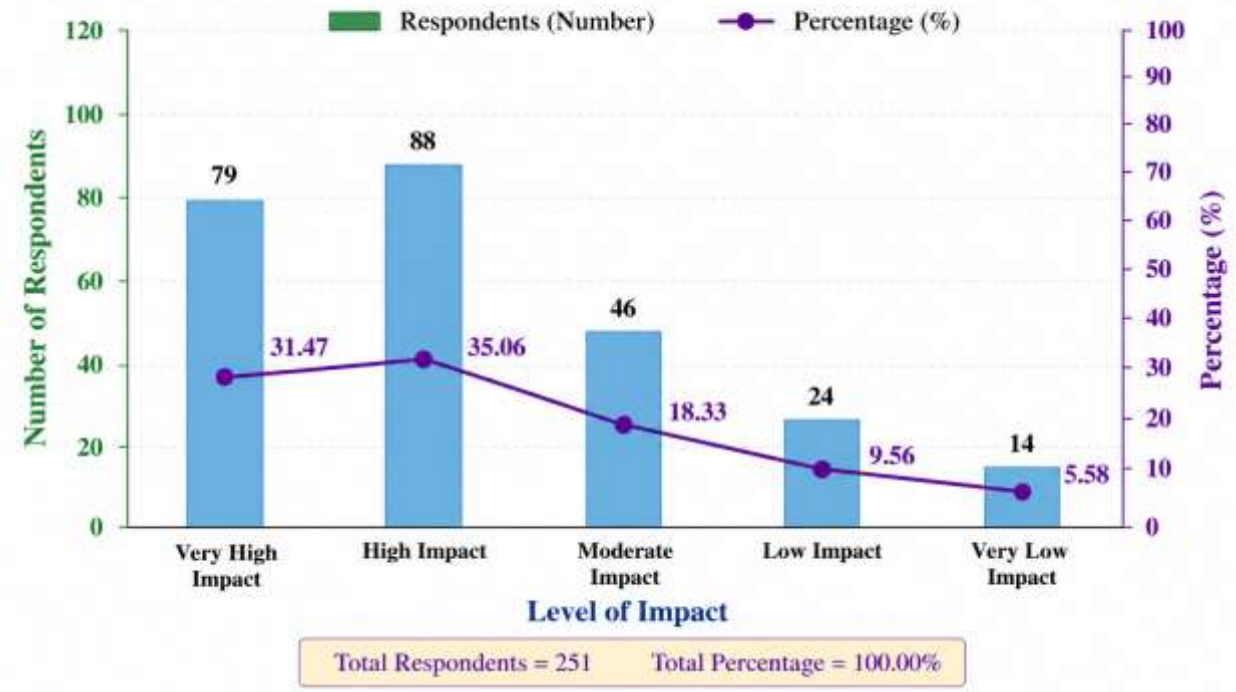
Interpretation

Impact assessment demonstrates a strong positive relationship between agricultural technology adoption and sustainable agricultural development. High impact was reported by 88 respondents (35.06%), while very high impact was indicated by 79 respondents (31.47%). Combined, these categories account for 167 respondents, representing 66.53% of the sample population. Moderate impact was reported by 46 respondents (18.33%), whereas only 38 respondents (15.14%) perceived low or very low impacts.

International Journal of Advanced Research and Multidisciplinary Trends (IJARMT)
An International Open Access, Peer-Reviewed Refereed Journal
Impact Factor: 7.2 Website: https://ijarmt.com ISSN No.: 3048-9458

The statistical distribution clearly indicates that more than two-thirds of farmers recognize technology adoption as a significant driver of agricultural sustainability. The difference of 51.39 percentage points between the combined high-impact categories and the combined low-impact categories highlights the overwhelmingly positive perception of technological interventions.

Fig. 5. Impact of Agricultural Technology Adoption on Sustainable Agricultural Development



Findings

1. Small farmers constituted the largest category of respondents.
2. More than half of the respondents exhibited high or very high levels of technology adoption.
3. Increased crop productivity was identified as the most significant benefit of technology adoption.
4. High investment costs and limited credit availability were the major adoption barriers.
5. Agricultural technologies positively influenced economic, environmental, and social dimensions of sustainability.
6. Farmers acknowledged the importance of technological innovations for long-term agricultural development.

Conclusion

The study concludes that agricultural technology adoption plays a vital role in promoting sustainable agricultural development in Chopra Tehsil, Uttar Dinajpur District, West Bengal. Modern technologies have enhanced agricultural productivity, increased farm income, improved resource-use efficiency, and supported environmental sustainability. However,

financial constraints, limited technical expertise, and inadequate institutional support continue to hinder wider adoption. Strengthening agricultural extension systems, improving credit accessibility, and promoting farmer-oriented training initiatives are necessary for accelerating sustainable agricultural transformation. Effective implementation of these measures will contribute substantially to achieving long-term agricultural sustainability and rural prosperity in the study area.The present study was undertaken to examine the influence of agricultural technology adoption on sustainable agricultural development in Chopra Tehsil, Uttar Dinajpur District, West Bengal. The findings clearly demonstrate that technological innovations have emerged as a significant catalyst for enhancing agricultural productivity, improving farmers' livelihoods, and promoting sustainable resource management. The study achieved all the stated objectives and provides important insights into the role of technology in transforming the agricultural sector.

With regard to the first objective, which aimed to examine the level of agricultural technology adoption among farmers, the findings revealed that a majority of respondents exhibited relatively high levels of technology adoption. Approximately 59.76% of the farmers reported high to very high adoption of modern agricultural technologies. This indicates a growing awareness among farmers regarding the benefits of improved seeds, mechanization, scientific nutrient management, digital advisory services, and modern irrigation practices. The increasing acceptance of technological innovations suggests a positive transition toward modernization and sustainability in the agricultural sector of Chopra Tehsil.

Concerning the second objective, which focused on identifying the perceived benefits of agricultural technology adoption, the study found that increased crop productivity was the most significant benefit reported by farmers. Improved farm income, efficient resource utilization, reduced production costs, and environmental sustainability were also recognized as important outcomes. These findings indicate that agricultural technologies contribute not only to economic advancement but also to environmental conservation and operational efficiency. The results further suggest that technology adoption enhances farmers' capacity to optimize agricultural inputs and achieve greater productivity while maintaining ecological balance.

The third objective sought to analyze the challenges faced by farmers in adopting agricultural technologies. The findings revealed that high initial investment costs constituted the most significant barrier to adoption. Limited access to agricultural credit, inadequate technical knowledge, poor extension services, and insufficient government support were also identified as major constraints. These challenges highlight the need for comprehensive policy interventions aimed at improving financial accessibility, strengthening institutional support systems, and expanding technical training programs. Addressing these barriers is essential for accelerating technology diffusion and ensuring equitable participation among farmers, particularly smallholders.

The fourth objective was to evaluate the impact of agricultural technology adoption on sustainable agricultural development. The findings demonstrated that 66.53% of respondents perceived a high or very high impact of technology adoption on agricultural sustainability. This confirms that technological innovations play a crucial role in improving productivity,

enhancing income generation, increasing resource-use efficiency, and supporting environmental sustainability. The positive relationship between technology adoption and sustainable agricultural development indicates that modern agricultural practices can effectively contribute to long-term agricultural resilience and rural prosperity. study concludes that agricultural technology adoption is a fundamental driver of sustainable agricultural development in Chopra Tehsil. The integration of modern technologies into farming systems has significantly enhanced agricultural performance while simultaneously promoting environmental stewardship and socio-economic development. Nevertheless, the persistence of financial, institutional, and knowledge-related barriers underscores the need for targeted interventions to maximize the benefits of technological innovation.

It is recommended that government agencies, agricultural extension departments, financial institutions, and development organizations collaborate to improve access to affordable technologies, provide technical training, strengthen extension services, and expand agricultural credit facilities. Such measures will facilitate broader technology adoption, enhance agricultural sustainability, and contribute to the long-term development of farming communities in Chopra Tehsil, Uttar Dinajpur District, West Bengal.

References

1. Bhattacharya, D. (2024). Sustainable farming practices and technological advancement in West Bengal. *Indian Journal of Sustainable Development*, 9(1), 55–71.
2. Government of India. (2024). *Agricultural Statistics at a Glance 2024*. Ministry of Agriculture and Farmers Welfare, Government of India, New Delhi.
3. Food and Agriculture Organization (FAO). (2023). *The State of Food and Agriculture 2023: Revealing the True Cost of Food to Transform Agrifood Systems*. Rome: FAO.
4. Sen, A., & Dasgupta, R. (2023). Agricultural transformation and technology adoption among farmers in Eastern India. *Journal of Rural Development*, 42(3), 315–332.
5. Rogers, E. M. (2003). *Diffusion of Innovations* (5th ed.). New York: Free Press.
6. Pretty, J. (2018). Sustainable intensification of agriculture. *International Journal of Agricultural Sustainability*, 16(1), 1–15.
7. World Bank. (2022). *Agricultural Innovation Systems: An Investment Sourcebook*. Washington, DC: World Bank Publications.
8. United Nations Development Programme (UNDP). (2022). *Sustainable Agriculture and Rural Livelihoods Report*. New York: United Nations Publications.
9. Singh, R., & Kumar, P. (2021). Technology adoption and sustainable agricultural development in rural India. *Indian Journal of Agricultural Economics*, 76(2), 215–228.
10. Das, A., & Ghosh, S. (2022). Modern agricultural technologies and farm productivity in Eastern India. *Journal of Rural Studies*, 82, 112–121.
11. Sharma, V., & Patel, N. (2020). Agricultural innovation and environmental sustainability: Evidence from Indian farming systems. *International Journal of Agricultural Sciences*, 12(4), 450–461.
12. Mukherjee, S. (2023). Agricultural modernization and rural transformation in West Bengal. *Journal of Regional Development Studies*, 18(2), 78–94.

13. Chandra, R., & Verma, A. (2021). Factors affecting technology adoption among farmers in India. *Agricultural Research Journal*, 58(5), 721–730.
14. Patel, M., Singh, D., & Yadav, P. (2022). Farm mechanization and sustainable agricultural productivity in India. *International Journal of Agricultural Research*, 17(3), 145–158.
15. Gupta, S., & Singh, R. (2020). Precision agriculture technologies and resource-use efficiency in crop production. *Journal of Sustainable Agriculture*, 14(2), 98–114.
16. Roy, P., & Banerjee, K. (2021). Digital agricultural advisory services and farmer decision-making in Eastern India. *Agricultural Extension Review*, 29(4), 201–216.
17. Kumar, V., Sharma, R., & Das, P. (2022). Climate-smart agricultural technologies and resilience among rural farming communities. *Climate and Development Studies*, 11(3), 187–203.
18. Mishra, S., & Sahu, B. (2021). Modern irrigation technologies and sustainable water management in Indian agriculture. *Indian Journal of Water Resources*, 41(2), 134–149.
19. Rao, T., & Reddy, M. (2020). Constraints in agricultural technology adoption among smallholder farmers. *Rural Development Perspectives*, 15(1), 67–81.
20. Ali, S., & Ahmed, N. (2022). Socio-economic impacts of agricultural innovation on rural livelihoods. *Journal of Agricultural Economics and Development*, 10(2), 89–105.