



The Role of Technology in Mitigating the Effects of Climate Change

Jimoh, Ajibola Johnson¹, Akinlotan, Oluyinka Omoyeni², Emmanuel, Oladele Jegede³ & Dongo, Enesi Isaac⁴

¹Department of Computer Science, Kogi State College of Education (T), Kabba

²Department of Chemistry, Kogi State College of Education (T), Kabba

³Department of Mathematics, Kogi State College of Education (T), Kabba

⁴Department of Metallurgical and Materials Engineering, Kogi State Polytechnic, Lokoja

Corresponding Author: ajibolajohnson9@gmail.com

Abstract

Climate change presents a critical threat to global ecosystems, economic stability, and human well-being. Its intensifying effects including rising sea levels, extreme weather events, and ecosystem disruptions demand innovative mitigation and adaptation strategies. Technological advancement remains central to these efforts, particularly in improving energy efficiency, reducing greenhouse gas emissions, and promoting sustainability across major economic sectors. This study examines the role of technology in mitigating climate change within transportation, agriculture, and manufacturing. A descriptive survey design was adopted, using a validated researcher-developed questionnaire administered to a sample of 150 respondents drawn equally from the three sectors. Reliability testing produced a Cronbach's alpha of 0.82, confirming the instrument's internal consistency. Descriptive statistics (percentages) were used for analysis. Findings revealed low availability and adoption of electric vehicles, limited access to renewable energy technologies in agriculture, inadequate industrial emission-control systems, and insufficient government incentives. The study concludes that strategic implementation of advanced technologies supported by robust policy frameworks and infrastructural investment can significantly reduce the impacts of climate change. It recommends increased government support, integration of renewable energy systems, and improved adoption of emission-reduction technologies across all sectors.

Keywords: Climate change, technology, mitigation, agriculture, transportation, manufacturing

Introduction

Climate change remains one of the most pressing global challenges of the twenty-first century. Its impacts driven primarily by anthropogenic activities such as fossil fuel combustion and deforestation include rising atmospheric temperatures, extreme weather events, sea level rise, biodiversity loss, and disruptions to food and water systems (Ge & Friedrich, 2020). These effects pose severe risks to human survival, economic growth, and ecological balance.

Technological innovation plays a vital role in mitigating these impacts. Advances in renewable energy, electric mobility, precision agriculture, carbon-capture systems, and energy-efficient

industrial processes are reducing dependence on fossil fuels and lowering emissions (Fawzy et al., 2020; Rissman et al., 2020). For instance, electric vehicles (EVs) are increasingly promoted as a cleaner alternative to internal combustion engine vehicles, with global projections showing a steady rise in EV adoption by 2040 (Fawzy et al., 2020). Similarly, precision agriculture using drones, sensors, and digital monitoring improves input efficiency and reduces agricultural emissions (Shirsath et al., 2021), while innovations such as solar irrigation and biogas systems provide cleaner energy options for rural farming

communities (Burney et al., 2017; Ahlgren et al., 2021).

Despite these advancements, the adoption of climate-friendly technologies remains low in many developing regions, including Nigeria. Barriers include inadequate infrastructure, weak policy support, limited awareness, and high implementation costs. Empirical assessments of technology adoption in key Nigerian sectors remain limited, particularly within transportation, agriculture, and manufacturing. This study addresses this gap by evaluating the availability of climate-mitigation technologies in these sectors and identifying the barriers hindering their implementation.

The purpose of the study is to assess how technology can be effectively deployed to mitigate climate change across selected sectors and to propose practical recommendations that will support wider adoption.

Research Questions

The study was guided by the following research questions:

1. Which technologies are available to mitigate greenhouse gas emissions in the transportation sector?
2. Which technologies are available to reduce the impact of climate change in the agricultural sector?
3. How can technological innovations in the manufacturing sector minimize negative environmental impacts?

Results

Research Question 1: Technologies in the Transportation Sector

Table 2: Availability of Transport-Related Climate Technologies

Question	Available	%	Not Available	%
Electric vehicles for transport operations	8	16%	42	84%
Alternative fuel infrastructure (e.g., CNG)	10	20%	40	80%
Autonomous vehicles	6	12%	44	88%
Government incentives for sustainable transport	12	24%	38	76%

The findings indicate very limited availability of low-carbon transport technologies. A large majority (84%) reported no access to EVs, while 80% indicated lack of alternative fuel infrastructure. Similarly, 88% reported no access to autonomous vehicles. Although

Methodology

A descriptive survey research design was employed to explore the role of technology in mitigating climate change across transportation, agriculture, and manufacturing. The population consisted of stakeholders in these sectors, including transport operators, farmers, and industrial engineers. A total of 165 questionnaires were distributed, and 150 were completed and returned, representing a high response rate.

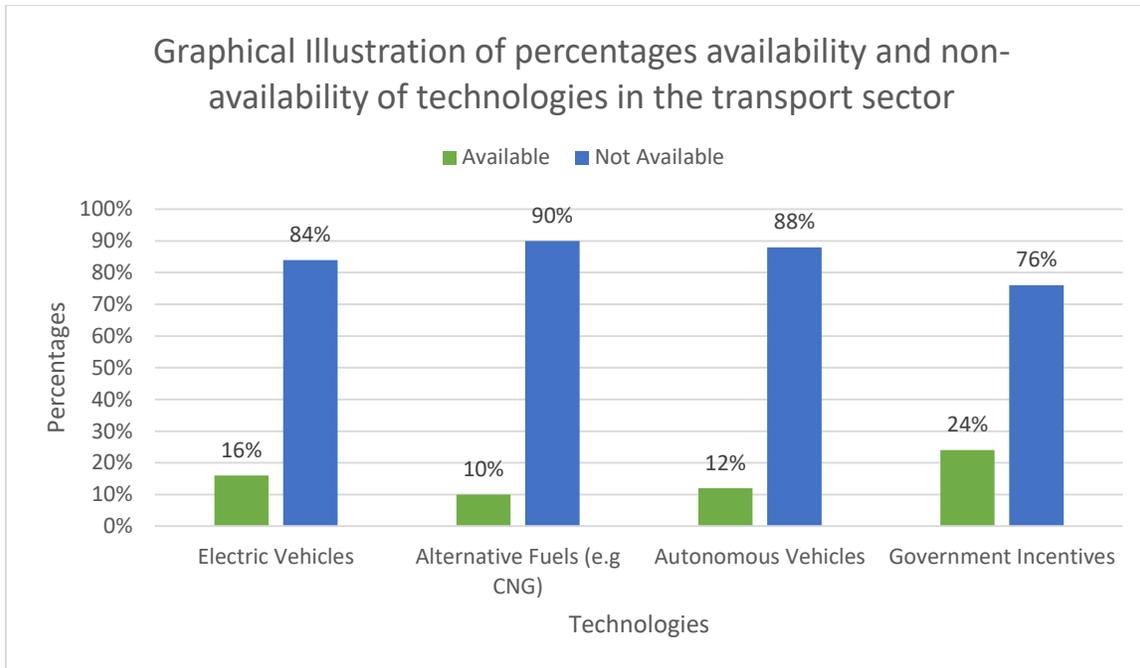
A structured questionnaire served as the primary data collection instrument. It was validated by experts in environmental science, engineering, and agricultural technology to ensure relevance and content adequacy. The reliability test using Cronbach's alpha yielded a coefficient of 0.82, indicating strong internal consistency. Data were analyzed using simple percentages to summarize the responses.

Table 1: Questionnaire Distribution and Retrieval

Sector	Administered	Returned
Agriculture	55	50
Transportation	55	50
Manufacturing	55	50
Total	165	150

24% acknowledged existing government incentives, most respondents perceived current support as inadequate.

The data presented in Table 1 is further illustrated in the graphically representation below:



Research Question 2: Technologies in the Agricultural Sector

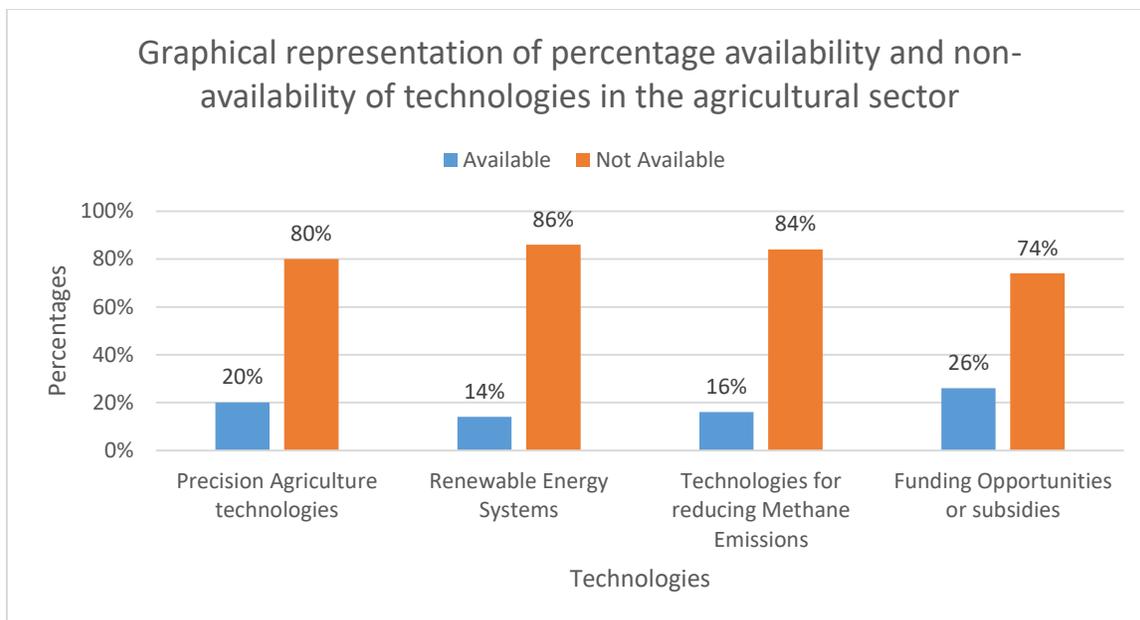
Table 3: Availability of Agricultural Climate Technologies

Question	Available	%	Not Available	%
Precision agriculture technologies	10	20%	40	80%
Solar-powered irrigation	7	14%	43	86%
Livestock emission-reduction technology	8	16%	42	84%
Government subsidies for climate-smart farming	13	26%	37	74%

Results show low adoption of agricultural climate technologies. Only 20% reported access to precision agriculture, while 86% lacked renewable-energy-based irrigation systems. Most respondents also

indicated limited access to emissions-reducing livestock technologies and inadequate government support.

The table is graphically represented as shown below:



Research Question 3: Technologies in the Manufacturing Sector

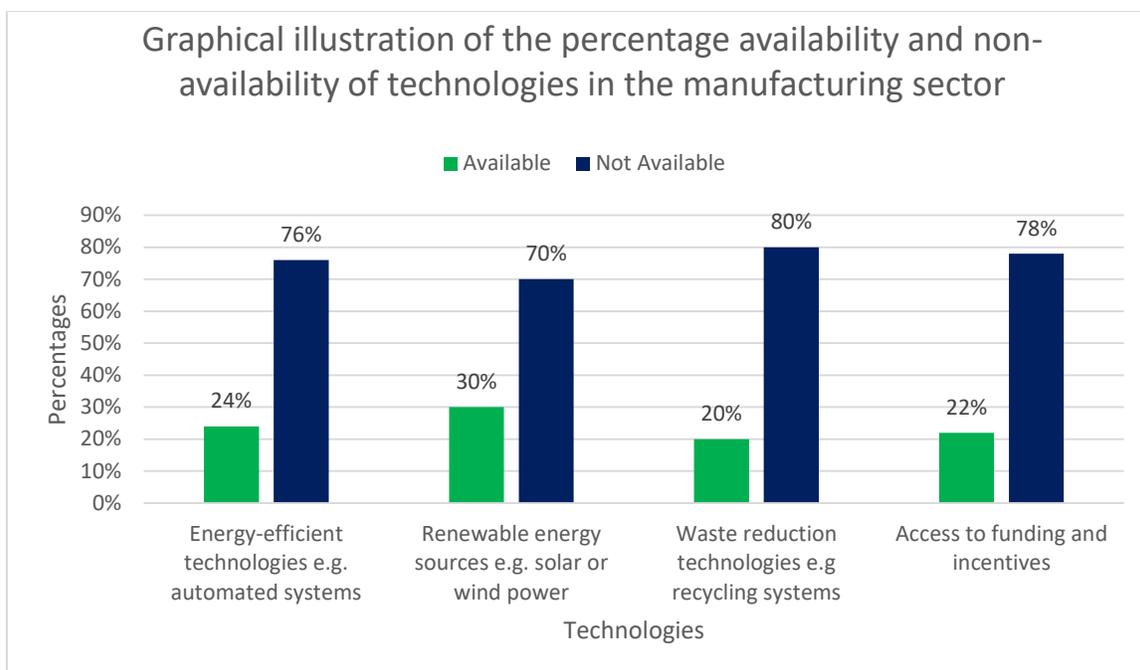
Table 4: Availability of Manufacturing Climate Technologies

Question	Available	%	Not Available	%
Energy-efficient emission control systems	12	24%	38	76%
Renewable energy sources	15	30%	35	70%
Mechanical/chemical recycling systems	10	20%	40	80%
Funding for green technologies	11	22%	39	78%

Findings reveal low integration of energy-efficient technologies and limited use of renewable energy in industrial operations. Most firms lacked recycling

systems and had little access to funding for green innovation.

The table above provides a graphic representation of the data described:



Discussion

The results reveal a significant technology adoption gap across all three sectors. In transportation, the absence of EV infrastructure and limited policy incentives mirror trends observed in other developing economies (Mock & Tietge, 2021). In agriculture, the low uptake of precision tools and renewable irrigation systems aligns with Burney *et al.* (2017), who noted that access and cost remain major barriers in rural regions. Similarly, the limited uptake of emission-reduction technologies in manufacturing reflects findings by Rissman *et al.* (2020), who emphasized that industrial decarbonization remains slow in emerging economies due to financing and infrastructural constraints.

Overall, the study highlights an urgent need for stronger technological investment, improved policy frameworks, and wider public-private collaboration to accelerate climate-mitigation efforts.

Recommendations

The study recommends the following:

Transportation: Government should expand EV infrastructure, introduce tax rebates, and invest in electrified public transport.

Agriculture: Promote renewable energy systems such as solar irrigation and expand funding for climate-smart farming.

Manufacturing: Encourage adoption of energy-efficient and recycling technologies through subsidies and low-interest loans.

Policy: Strengthen regulatory frameworks and provide financial incentives for emission-reduction technologies.

Collaboration: Foster international partnerships for technology transfer and capacity building.

Conclusion

Technology plays an indispensable role in mitigating climate change. Despite its potential, adoption remains significantly limited across Nigeria's transportation, agriculture, and manufacturing sectors. Wider implementation of renewable energy systems, emission-reduction technologies, and smart digital tools supported by robust government policies and incentives can substantially curb greenhouse gas emissions and promote sustainable development. Accelerating technological deployment is therefore essential for national resilience in the face of climate change.

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