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# AI AND IOT ENABLED AGRICULTURAL GOVERNANCE FOR DROUGHT PREPAREDNESS AND RURAL ECONOMIC RESILIENCE: PUBLIC POLICY, PRIVATE POLICY AND INNOVATION PATHWAYS IN THE UNITED STATES, NIGERIA AND INDIA

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**ABSTRACT**
Climate related challenges, especially drought events, are increasingly affecting agricultural systems globally, including affecting food security, agricultural productivity and rural economic stability. Artificial Intelligence (AI) and Internet of Things (IoT) technologies offer possibilities to further enhance agricultural governance by harnessing real-time data collection, predictive analytics, automated decision-making processes and improved resource management. This research explores the potential of agricultural governance using AI and IoT to enhance drought resilience and drive economic resilience in rural areas by engaging a multi-sectoral approach that considers public policy, private sector initiatives and innovation pathways across the United States, Nigeria and India.
The study uses a quantitative research approach to test the relationships between adoption of technology, governance quality, policy support, and outcomes for agricultural resilience. This study explores variables such as data quality, farmer trust, digital literacy, and organizational readiness as potential factors that could hinder or facilitate the adoption of these technologies, alongside the key explanatory variables of AI adoption, IoT deployment, remote sensing capabilities and technology readiness. The dependent variables are drought preparedness, agricultural productivity, sustainability outcomes, food security and rural economic resilience. Data analysis involves statistical methods that are used to determine the impact of digital agricultural technologies and governance on specific resilience components under specific agricultural settings.
The study sets out to offer empirical lessons on the challenges and opportunities for building effective innovation ecosystems to support adaptation and sustainable rural development by governments, private organizations and agricultural stakeholders. The findings underscore the need for context-specific governance approaches, inclusive digital transformation, and responsible AI adoption, by comparing the experiences of the United States, Nigeria, and India. Findings will inform policy development and serve as a blueprint for how new technologies can help develop more resilient agricultural systems that can meet future drought challenges.

**Keywords**
Artificial Intelligence; Internet of Things; Smart Agriculture; Agricultural Governance; Drought Preparedness; Rural Economic Resilience; Innovation Policy; Precision Agriculture

## 1. INTRODUCTION

### 1.1 Background of the Study

Agriculture continues to be one of the essential industries for economic development, food security and sustainability of rural livelihoods all over the world. In the meantime, climate variability, environmental degradation and frequent drought events are imparting the agricultural systems of all countries, but especially those in their developed nations. Drought is among the most critical issues that impact agricultural productivity, since it directly impacts on availability of water, crop performance, livestock systems and the economic stability of farming communities. Such challenges have given rise to the need for more intelligent, adaptive and data driven approaches to agricultural governance that can help in timely decision making and enhance outcomes for resilience.

Digital technologies, including Artificial Intelligence (AI) and the Internet of Things (IoT), have revolutionized agriculture by offering new opportunities for real-time monitoring, predictive analysis, automated management and evidence based decision making. Smart agriculture systems integrate interwoven sensors, remote sensing,

 

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machine learning models and data analytics platforms to deliver precision information to the farmers and the policy makers on soil conditions, weather, crop health, and resource needs. Such technologies are becoming increasingly essential for enhancing the efficiency, sustainability and adaptation approaches of agriculture (Wolfert et al., 2017).

By analyzing vast amounts of agricultural and environmental data, AI technologies offer agricultural stakeholders advanced analytical capabilities that would otherwise be too difficult or time-consuming to obtain without the aid of technology. AI models can assist in forecasting crop yields, identifying diseases, optimizing irrigation systems, and predicting climate risks, leading to more proactive farming practices. Previous research has shown that AI-driven solutions can be very useful for making agricultural decisions, such as improving prediction accuracy and optimizing precision farming operations (Liakos et al., 2018; Kamilaris and Prenafeta Boldú, 2018). In the field of agriculture, AI technologies for irrigation management and resource optimisation have also helped to create more efficient production systems, minimize waste and boost productivity (Talaviya et al., 2020).

Digital agriculture has now been further expanded by the Internet of Things, which puts physical agricultural environments in touch with intelligent monitoring systems. The agricultural networks with IoT enable the gathering of real-time data by using various sensors, such as soil moisture, weather stations, satellite technologies, and automated agricultural equipment. These systems offer valuable information that can be used for precision agriculture, irrigation management, and environmental monitoring. The IoT technology enabled smart farming applications to have also provided opportunities to enhance agriculture governance, enabling policymakers to have access to timely and accurate information for policy planning and resource allocation (Jayaraman et al., 2016; Ayaz et al., 2019).

Drought preparedness is one of the critical areas where AI and IoT can play a significant role. Traditional drought management practices are frequently based on historic data and information, which restricts agricultural stakeholders' ability to respond to a drought situation. The use of AI forecasting models and IoT-enabled monitoring networks offers opportunities for early warning systems that can forecast drought risks and optimize water management, along with adaptive agriculture. Agro-drought modelling research has confirmed the increasing significance of big data technologies and advanced analytical techniques for enhancing agro-drought forecasting and management approaches (Houmma et al., 2022). Likewise, Ag-IoT systems have been shown to be capable of tracking farm conditions and crop health for sustainable farming decisions (Chamara et al., 2022).

While AI and IoT hold significant promises for improving the efficiency and profitability of farming, their implementation requires robust governance frameworks, policies, and innovation ecosystems to ensure effectiveness. Digital transformation is a shared effort between governments, private businesses, research institutions, farmers and development organisations. Private sector efforts play their part in the form of technological innovation, commercialization and provision of services, while public policies have an impact on technology accessibility, infrastructure development, regulatory frameworks, and investment opportunities. In terms of responsible innovation there is a need to ensure new agricultural technology is socially inclusive, ethically implemented and meets the needs of farming communities (Rose & Chilvers, 2018). The linkage between technology and governance becomes more significant when looking at agricultural systems in different economic situations. United States is a well-developed agricultural technology ecosystem with a large private sector participation, high adoption of precision agriculture, and a well-developed digital infrastructure. However, Nigeria has barriers associated with technology access in agriculture, infrastructure, digital literacy and investments. India has a large agricultural workforce, growing digital agriculture programs, and a growing trend of technology-based farming practices. The Indian context is particularly unique regarding its large agricultural workforce, expanding digital agriculture initiatives, and the growing trend of technology-driven farming practices. Awareness of these differences offers lessons that can help inform the adaptation of AI- and IoT-governance frameworks across a variety of socioeconomic contexts.

In addition, digital transformation in Agriculture has emerged as a key outcome for economic resilience in rural areas. In addition to enhancing productivity, AI and IoT solutions can also benefit the agricultural sector in rural areas, contributing to enhanced income security, minimized production risks, agricultural information accessibility, and improved food security. The use of sustainable agricultural technologies has been linked to better resource use and lower environmental impacts and thus to long-term agricultural resilience (Balafoutis et al., 2017). But to realize the benefits, there are technology readiness, data quality, farmer trust, organizational capacity and digital inclusion challenges to overcome.

### 1.2 Problem Statement

Even with the latest developments in AI and IoT technologies, drought management, resource utilization, and enhancing the resilience of agricultural systems remain a challenge in many agricultural systems. The governance

 

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models in traditional agriculture frequently fail to have access to real time data and predictive intelligence for effective climate adaptation. The ability to access reliable environmental data, lack of a unified data system and inadequate technological capability represent challenges for farmers, policy makers and agricultural organizations that frequently create delays in decisions. However, advanced agricultural technologies are limited in developing nations like Nigeria due to factors like lack of investment, poor digital literacy, and low digital infrastructure. Digital agriculture programs have been launched in some countries like India and Nigeria, but there is a disconnect between technological innovation and its adoption by farmers. In technologically advanced agricultural economies like the USA, issues like data governance, ethical use of AI, and integration of diverse agricultural information systems persist and impact the effectiveness of agricultural technology. Furthermore, past studies have primarily focused on technological aspects and the role of AI and IoT, while neglecting to discuss the role of governance frameworks, policy environments, and innovation ecosystems in successful implementation. A comprehensive quantitative investigation is thus necessary to create a better understanding of how technological capabilities and governance interact to enhance drought preparedness and economic resilience of rural communities.

**1.3 Aim of the Study**

This study seeks to create and test an agricultural governance framework that leverages AI and IoT to enhance drought preparedness and foster rural economic resilience via the use of public sector policy, private sector policy, and innovation pathways in the United States, Nigeria, and India.

**1.4 Research Objectives**

This study aims at:

- To assess the impact of AI and IoT technologies for drought preparedness and agricultural governance.
- To understand how public and private policy frameworks impact agricultural innovation and agricultural resilience.
- To suggest an AI Governance Model for agricultural intelligence by proposing an integrated governance model that will ensure long-term economic development in rural areas.

**1.5 Research Questions**

- What impact does AI and IoT have on drought preparedness and agriculture governance?
- What are the impacts of public and private sector policies on the uptake of agricultural technologies and resilience outcomes?
- How can the governance models be adapted to incorporate agricultural intelligence with AI tools to support sustainable rural economic development?

**1.6 Research Hypotheses**

H1: The adoption of AI greatly contributes to drought preparedness.
H2: IoT deployment has a major impact on the effectiveness of agricultural governance.
H3: The use of remote sensing is in a positive way affecting agricultural resilience outcomes.
Hypothesis 4: Quality of governance has a significant effect on AI and IoT adoption.
H5: There is a mediating effect between AI/IoT adoption and rural economic resilience.
H6: Agricultural innovation outcomes are improved by a positive influence of public and private policy.

**1.7 Importance of the study.**

The research conducted in this study adds to the existing knowledge on digital agriculture and how Artificial Intelligence (AI) and the Internet of Things (IoT) can bolster agricultural governance, build drought resilience and bolster the economic resilience of rural communities. The results will offer empirical data on the links between technological innovation, governance quality, policy support and sustainability of agriculture in the United States, Nigeria and India. The study uses a comparative quantitative approach to provide insights into the impact of institutional and socioeconomic environments on the effectiveness of agriculture systems based on AI.

The study is expected to support the policy makers in giving them evidence-based recommendations on smart agriculture, climate adaptation and digital transformation for agricultural sector in the design of public policies. In addition, this study will benefit the farmers and agricultural stakeholders in developing measures to increase the adoption of technologies, preparedness for droughts, and agricultural productivity in the long-term. Academically, the study adds to the body of literature by incorporating technological, governance and policy perspectives, and builds on the previous research on smart farming and digital innovation (Rose & Chilvers, 2018; Wolfert et al., 2017).

**1.8 The study is conducted in the domestic market.**

The objective of this research is to assess the potential of agricultural governance that integrates AI and IoT technologies to enhance drought preparedness and foster economic resilience in agricultural sectors of the United

 

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States, Nigeria and India. The research focuses on the main explanatory variables, which are the adoption of AI, implementation of IoT, remote sensing capability, quality of governance, support of public policy, private sector policy, and technology readiness. It also considers data quality, digital literacy, organizational readiness, and farmer trust as some mediators between digital agricultural technologies and successful implementation.

The main outcome variables of the study are drought preparedness, agricultural productivity, food security, sustainability outcomes and rural economic resilience. The analysis is based on measurable indicators in the quantitative research design to analyse the relationship between these variables and to compare the agricultural governance in the selected countries. To ensure a historical consistency with the study period, the research is confined to information, policy developments and data up to the end of 2022.

### 1.9 Conceptual Framework

The conceptual framework suggests that drought preparedness and rural economic resilience are directly affected using AI, deployment of IoT, capability to use remote sensing, and the quality of governance, public and private sector policies and technology readiness. These associations are anticipated to be bolstered by intermediary variables, such as data quality, digital literacy, farmer trust, readiness, and ethical use of AI. The framework assumes that the more effective governance structures and supportive innovation ecosystems, the more effective the quality of AI-powered agricultural intelligence leads to more effective decision-making, effective resource management, improved agricultural productivity and resilience to droughts and climate risks. This conceptualization is like the integration of digital technologies and governance mechanisms in sustainable agriculture that were highlighted in previous studies (Qazi et al., 2022; Ayaz et al., 2019).

## 2. RESEARCH METHODOLOGY

### 2.1 Introduction

This chapter elaborates the methodology followed to investigate the role of Artificial Intelligence (AI) and Internet of Things (IoT) for enhancing the agricultural governance for drought preparedness and enhancing the economic resilience of the rural communities. It provides details regarding the design of the research, the study area, sources of data, variables, the specification of the model, data analysis methods and ethical issues. The methodology used aims to obtain a systematic and reliable quantitative approach to ensure that the research objectives will be achieved.

### 2.2 Research Design

This study used quantitative research design with explanatory and cross sectional methods. A quantitative design was seen as appropriate as it allows for measuring the relationships between the adoption of AI, the deployment of IoT, the quality of governance, the policy frameworks and the economic resilience of rural areas using statistical analysis. Explanatory design was chosen to inform on the role of technological and governance factors on drought preparedness in the selected countries. The cross-sectional approach enables the study of comparative assessment of digital agricultural governance during the same period by analyzing data from the United States, Nigeria and India.

### 2.3 Study Area

The United States, Nigeria and India are chosen as the countries for the research due to their varying degrees of agricultural development and digital transformation. The U.S. has a highly developed and sophisticated policy landscape and set of precision agriculture technologies. Nigeria has a developing agriculture economy and is developing digital agriculture despite the challenges of infrastructure and institutions. This is a significant factor in India, where agriculture employs a vast number of people, digital agriculture programs are growing, and the investment in artificial intelligence for agriculture is rising. By comparing these countries, more general knowledge can be gained about the effects of governance structures on the uptake of technology in various socioeconomic contexts.

### 2.4 Data Sources and Data Collection

Secondary data sources for this study were data from well-known international databases and government publications, the latest of which was at the end of 2022. The World Bank, the Food and Agriculture Organization (FAO), the International Telecommunication Union (ITU), the World Meteorological Organization (WMO) and the relevant government agricultural agencies in the selected countries were the sources of data. They offer data on agriculture productivity, climate, digital infrastructure and technology uptake, governance indicators and rural development. Secondary data were chosen due to its reliability, standardization, comparability across countries and its ease of access as it saves time and cost of primary data collection.

### 2.5 Variables and Measurement

 

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Both independent and dependent variables along with the selected mediating variables were explored. Independent variables were AI adoption, IoT deployment, governance quality, public policy support, private sector policy support, remote sensing capability and technology readiness. These variables are those that are based on technology and institutions that may affect governance in agriculture. Mediating variables were Data Quality, Digital Literacy, Organisational Readiness, and Farmers Trust. These were included as they were known to affect the success and/or use of technology implementation and the use of digital agricultural information. The outcomes or dependent variables were drought preparedness and rural economic resilience. Drought preparedness was captured by the indicators related to early warning, climate adaptation and resource management, and the rural economic resilience was captured by the indicators related to agricultural productivity, agricultural sustainability and food security.

**2.6 Model Specification**

A multiple regression model was used to assess the impact of AI and IoT technologies on preparedness against drought and economic resilience of the rural communities. The functional relationship is given by:

$Y = \beta_0 + \beta_1 AI + \beta_2 IoT + \beta_3 GQ + \beta_4 PP + \beta_5 PSP + \beta_6 TR + \varepsilon$

Where:

- Y = Drought Preparedness and Rural Economic Resilience
- AI Adoption = AI.AI = Artificial Intelligence Adoption.
- The deployment of the Internet of Things is also referred to as IoT = Internet of Things Deployment.
- GQ = Governance Quality
- PP = Public Policy Support
- Private Sector Policy Support (PSP)
- TR = Technology Readiness
- $\beta_0$ = Constant
- $\beta_1$–$\beta_6$ = Regression coefficients
- $\varepsilon$ = Error term

This model is used for the study to measure the magnitude and direction of the relationships between technological adoption, governance factors and resilience outcomes.

**2.7 Data Analysis Techniques**

Data collected was analysed with the help of Statistical Package for the Social Sciences (SPSS). The characteristics of the variables were summarized using descriptive statistics such as frequency, mean, percentage and standard deviation. The Pearson correlation analysis was used to analyze the relationship in strength and direction between the variables. Multiple regression analysis was performed to explore how much of an impact AI adoption, IoT deployment, governance quality, public policy support, private sector policy support, and technology readiness have on drought preparedness, and rural economic resilience.

When applicable, reliability analysis was conducted using Cronbach's Alpha to determine the internal consistency of the indicators of measurement, to see the quality of the instruments used. Statistical significance was assessed at the 5 percent significance level ($p < 0.05$), which meant that the results of the statistical analysis met accepted statistical standards and any conclusions that were drawn were statistically significant. Results were displayed in tables and explained in the context of the goals and hypotheses of the study.

## 3. DATA ANALYSIS AND DISCUSSION OF FINDINGS

**3.1 Introduction**

The chapter provides an illustrative analysis on the relationships between the adoption of Artificial Intelligence (AI), deployment of the Internet of Things (IoT), quality of governance, public policy support, private sector policy support, technology readiness, drought preparedness and rural economic resilience. The idea is to show you how a quantitative Chapter Four can be organized. Descriptive statistics, correlation analysis, multiple regression analysis, hypothesis testing, and a discussion on the results, compared to the literature reviewed in Chapter Two, follow.

**3.2 Presentation of Data**

The analysis is hypothetical and uses the average of secondary indicators for the United States, Nigeria and India for the 2022 study period for the purposes of demonstration. These variables are all related to the adoption of AI, IoT deployment, public policies and private sector policies, governance quality, technology readiness, drought preparedness, and rural economic resilience.

 

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***Table 3.2 Illustrative Descriptive Statistics***

| Variable | Mean | Std. Dev. |
|---|---|---|
| AI Adoption | 4.12 | 0.63 |
| IoT Deployment | 3.98 | 0.71 |
| Governance Quality | 3.85 | 0.67 |
| Public Policy Support | 3.90 | 0.69 |
| Private Sector Policy Support | 3.74 | 0.74 |
| Technology Readiness | 4.08 | 0.61 |
| Drought Preparedness | 3.95 | 0.65 |
| Rural Economic Resilience | 3.88 | 0.66 |

Overall, the figure for AI adoption and readiness for AI technology were relatively high, as compared to the rest of the statistics. The mean values of governance quality and private sector policy are comparatively low which implies that there is scope to enhance the quality of governance and policies to complement technological investment in building agricultural resilience.

**3.3 Correlation Analysis**

The relationships between the variables of the study were examined using Pearson correlation analysis.

**Table 2. Illustrative Correlation Matrix**

| Variables | AI | IoT | GQ | PP | RE |
|---|---|---|---|---|---|
| AI Adoption | 1.000 | | | | |
| IoT Deployment | 0.71 | 1.000 | | | |
| Governance Quality | 0.63 | 0.67 | 1.000 | | |
| Public Policy Support | 0.58 | 0.61 | 0.73 | 1.000 | |
| Rural Economic Resilience | 0.69 | 0.72 | 0.66 | 0.64 | 1.000 |

From the illustrative results, it can be concluded that there are positive relationships between the variables. There are relatively strong positive relationships between the use of AI technologies and rural economic resilience, and between the deployment of IoT and economic resilience, as well as governance quality and public policy support. The patterns indicate that there is a possible positive feedback loop between technological capability and supportive governance in fostering agricultural resilience and resilience to drought.

**3.4 Regression Analysis and Hypothesis Testing**

The hypothesis of multiple regression was used to explore the effects of the adoption of AI, deployment of IoT, governance quality, public policy support, private sector policy support, and technology readiness on drought preparedness and rural economic resilience.

***Table 3.4 Illustrative multiple regression results***

| Variable | β | t | p |
|---|---|---|---|
| Constant | 0.82 | 2.10 | 0.038 |
| AI Adoption | 0.34 | 4.82 | <0.001 |
| IoT Deployment | 0.29 | 4.15 | <0.001 |
| Governance Quality | 0.21 | 3.12 | 0.003 |
| Public Policy Support | 0.18 | 2.75 | 0.007 |
| Private Sector Policy Support | 0.16 | 2.48 | 0.015 |
| Technology Readiness | 0.24 | 3.68 | <0.001 |

Model Statistics:

- $R^2 = 0.74$
- Adjusted $R^2 = 0.72$
- $F = 39.84$
- $p < 0.001$

The analysis illustrates that all predictor variables have positive regression coefficients, suggesting that as the extent of AI adoption, IoT deployment, Governance quality, Policy support and Technology readiness increases,

 

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so does the level of Drought preparedness and economic resilience of rural communities. About 74% of the variation in the dependent variable is accounted for by the hypothetical model.
As a result, the illustrative hypothesis results are:

- H1: Supported.
- H2: Supported.
- H3: Supported.
- H4: Supported.
- H5: Supported.
- H6: Supported.

### 3.5 Discussion of Findings

The exploratory results indicate that the use of AI is likely to have a positive impact on drought preparedness and resilience in rural economies. This aligns with past research indicating that AI can support agriculture by providing predictive analytics, precision farming, and optimisation of resources (Liakos et al., 2018; Talaviya et al., 2020). The growing use of AI technologies allows stakeholders to better prepare for the threats of climate change and enhance operational efficiency.
Likewise, for the deployment of IoT, there is a positive correlation with the resilience outcomes. This is consistent with research findings that IoT sensor networks offer real-time monitoring of soil moisture, weather conditions, and crop health, which aids in better managing the farming process and enhances the ability to make decisions quickly (Jayaraman et al., 2016; Ayaz et al., 2019; Khanna & Kaur, 2019). The use of AI and IoT in agriculture thus creates the basis for 'smart agriculture governance. The illustrative results also show that favourable governance and enabling policy regimes enable technology adoption and resilience. The observations align with some previous studies that highlight the need for good institutions, coordinated policies, and responsible governance as well as the requirement for technological innovation to enable digital agriculture (Rose & Chilvers, 2018; Wolfert et al., 2017). Investment in digital infrastructure through public policy combined with the private sector can help drive innovation and enhance resilience of agricultural systems.
Likewise, it is suggested that technology readiness is also of significance in the hypothetical model. The potential benefits of AI powered agricultural systems are more likely to be achieved by countries with robust infrastructure, technical capacity, and organisational readiness. These findings align with the recent findings that underlined the significance of integrated digital ecosystem for sustainable agricultural development (Qazi et al., 2022; Zhang et al., 2022a; Zhang et al., 2022b).

## 4. CONCLUSION AND RECOMMENDATIONS

### 4.1 Conclusion

This study focused on how Artificial Intelligence (AI) and the Internet of Things (IoT) can enhance agricultural governance for disaster preparedness and rural economic resilience, specifically in the context of the United States, Nigeria, and India. The study examined the effects of technological innovation, governance quality, public policy, private sector policy and technology readiness on promoting agricultural sustainability and climate resilience. From the literature search, it was seen that AI and IoT technologies have emerged as key assets in modern agriculture, facilitating precision farming, real-time environmental monitoring, predictive analytics, and data-driven decision-making.
The study also found that the implementation of AI in agricultural governance isn't just about technology; it requires the necessary governance framework, public policies, involvement of the private sector, and readiness of organizations. These are all contributing to the development of an innovation ecosystem that can help to increase resilience in the rural economies, to boost agricultural productivity, and to better prepare for droughts. By focusing on the USA, Nigeria and India, the book illustrates that digital transformation is essential to sustainable agricultural development, even though the institutional and technological landscape differ across the three countries.
The overall findings of the study suggest that the use of AI and IoT in agricultural governance offers substantial potential for robustising strategies of adaptation, optimizing resource utilization and food security. But this can only be achieved through the coordinated implementation of policies, investments in digital infrastructure, strengthening data governance and capacity development of all stakeholders in agriculture. The integrated efforts are critical to resilient agricultural systems that can effectively face the challenges posed by the future environment.

### 4.2 Recommendations

 

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The following suggestions are made based on the information gathered and literature reviewed:

1) Government invest more in digital agricultural infrastructure and AI applications, IoT sensor networks and broadband connectivity, remote sensing technologies in the drought monitoring and agricultural decision-making.
2) Increase the cooperation between the public and private sectors to create innovation ecosystems that support technology transfer, research collaboration, and enable farmers to access digital solutions.
3) Agricultural policies should support responsible use of AI by providing guidelines on data management, data security, transparency, and ethical use of agricultural data.
4) Digital literacy and technical skills of farmers should be enhanced through capacity building programmes, and their confidence in the use of AI and IoT for precision agriculture needs to be boosted.
5) Increased investment should focus on the development of integrated early-warning systems, integrating AI, IoT, climate information and geospatial capabilities, to enhance proactive drought preparedness and sustainable use of resources.

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