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The Application Of Artificial Intelligence Towards Accelerating Implementation Of Select SDGS: A Review

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Abstract:
Achieving United Nations Sustainable Development Goals (SDGs) by 2030 will need innovation and collaboration. It can be accelerated by artificial intelligence (AI), which is emerging as a powerful technological tool. AI is used in addressing SDG 2 (agriculture), SDG 3 (health) and SDG 13 (climate) by converting precise data into actionable knowledge. Climate change acts as a cross-cutting stressor that impacts agricultural systems and human health. AI tools can facilitate climate-resilient adaptation strategies to reduce climate vulnerability, strengthen food security, and improve public health, thereby strengthening outcomes across all three interconnected SDGs.
Different AI technologies such as computer vision, machine learning, natural language processing, and predictive modeling are shown to support precision agriculture, boost crop productivity, improve disease diagnosis, facilitate telemedicine, optimize renewable energy systems, and improve climate forecasting and disaster preparedness. Despite these innovations having great potential in accelerating SDG implementation, several key challenges exist across developing and developed economies: data constraints, unequal technology access, ethical and privacy issues, high costs.
To optimize AI's developmental advantages, it is imperative to promote and implement its responsible, inclusive, and regulated use. Strengthening ethical frameworks, digital literacy, gender considerations, and equitable access to technology will ensure effective and inclusive development. This paper presents a conceptual framework for AI-enabled integration of three interlinked SDGs along with a set of recommendations to guide the responsible use of AI for accelerating SDG implementation.
An accountable, equitable, and sustainable AI system will enable technological innovation and lead to the implementation of the 2030 Agenda.
Key Words: *Artificial intelligence, SDGs, agriculture, public health, climate change, AI in SDGs, sustainable development.*

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I. Introduction

The power, impact, and increased reliability of artificial intelligence (AI) applications is undeniable. The past decade has made major strides in domain-specific applications of AI. However, the concept of AI is not recent but dates back several decades. In 1956, John McCarthy of Stanford University first used the term 'artificial intelligence' at a conference held in Dartmouth, USA. The global AI market size was estimated at USD 371.71 billion in 2025 and is expected to reach USD 2,407.02 billion by 2032[1]. This growth is triggered by improved data availability and reliability as well as democratization of AI through cloud-native platforms such as AWS Bedrock, Microsoft Copilot Studio, NVIDIA DGX Cloud, and Google Vertex AI. Simply put, AI is an applied computer science discipline that focuses on allowing machines to replicate human intelligence and problem-solving abilities. The use and application of AI have increased exponentially and span across all aspects of daily life to solving global challenges.

With rapid population growth, industrialization and urbanization, the persistence of global inequality within and between countries has led to inequality in livelihood, education, energy, food security, gender equity, and public health systems. In 2015, the United Nations (UN) endorsed the blueprint for 'a better and more sustainable future for all': the 2030 Agenda for Sustainable Development with 17 Sustainable Development Goals (SDGs). Sustainable development was earlier defined by the UN Brundtland Commission in 1987 as "meeting the needs of the present without compromising the ability of the future generations to meet their own needs"[2]. Achieving SDGs by 2030 requires innovation and collaboration, and AI can accelerate its pace in several ways.

In the above context, this paper examines the role and contribution of AI in accelerating three specific SDGs across the social, economic and environmental dimensions of development (Figure 1):

i. SDG 2 (Zero hunger): End hunger, achieve food security and improved nutrition and promote sustainable agriculture

ii.SDG 3 (Good health and well-being): Ensure healthy lives and promote well-being for all, at all ages
iii.SDG 13 (Climate action): Take action to combat climate change and its impacts

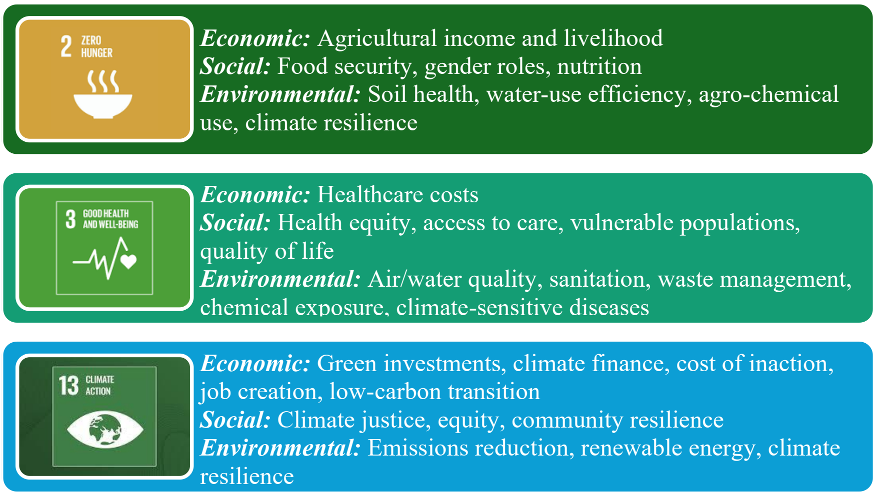

Figure 1: Acceleration potential of AI across social, economic and environmental dimensions of three SDGs

This paper focuses on exploring the potential and limitations of AI in achieving the three specific SDGs, highlighting key applications, case examples, and socio-ethical considerations. The key research questions are:

- What are the different types of AI technologies currently used in agriculture, health and climate action projects, and how are they applied?
- To what extent can AI applications effectively accelerate SDG 2, 3, and 13?
- What are the potential downsides of AI integration in key sectors like health and agriculture, particularly crucial risks and socio-ethical challenges?
- What are the key actionable recommendations to ensure inclusive, ethical, and sustainable use of AI technologies in accelerating or achieving these SDGs?

II. Approach And Methodology

A systematic literature review methodology was used for the study. Relevant research articles and scientific documents were identified by applying a specific selection of keywords to study the following topics: “AI in SDGs”, “health”, “climate action”, “agriculture”, “sustainable development”, etc. Academic publishing and research sharing platforms and databases like Springer (Springer Nature), ResearchGate and ScienceDirect (Elsevier), as well as UN reports and academic and research reports were used to explore and review the available literature. Publicly accessible resources, including websites of government agencies, the UN, other international organizations, and research institutions, were obtained from internet sources. The bibliographies of the obtained research articles and materials were queried and added at the end of this paper. Information sources like social media, blogs, op-eds, or personal articles were excluded from the study.

III. Mapping AI To SDGS

SDG 2: AI in agriculture

Agriculture is a key economic sector that offers food security and nutrition, while facing several challenges like changing climatic conditions, groundwater depletion, soil /water pollution, and increased food demand due to rapid population growth. The *World Food Programme* estimates that about 318 million people in 68 countries are facing acute hunger[3]. AI can help in addressing SDG 2 through the application of technologies by converting precise data into actionable knowledge to help enhance crop productivity and management, improve climate resilience, facilitate soil and water quality monitoring, and in disease and pest detection[4].

Crop productivity

- Predictive *machine learning (ML)* models on crop productivity helps analyze historical data on weather patterns, soil health, and crop performance. Artificial neural networks (ANNs) are computational ML models made of interconnected processing units helping in crop yield prediction[5].
- *Expert systems* provide decision-making ability equivalent to a human expert by using rule-based algorithms on crucial factors like crop selection that can help in increased crop production. EXOWHEM is a rule-based

expert system for wheat crop production in India providing advice on agricultural operations, fertilizer application and crop variety selection[6].

Precision irrigation

- *Reinforcement learning* (RL) is an advanced AI application that teaches machines to make decisions by interacting with their environment and learning from the results. For example, it might know when and how much water needs to be applied based on soil moisture levels, weather forecasts, and other needs of the plant. A deep Q-learning (DQN) based irrigation decision-making strategy was used to optimize irrigation decision in paddy farms in Nanchang, China, using weather forecast data[7].

Plant pest and disease management

- *Computer vision* allows visual data interpretation through AI-equipped cameras to monitor crops and detect plant diseases and weed growth[4]. *Expert systems* help farmers to make informed decisions about planting, pest control, fertilizer application, etc. to maximize yields. A WebGIS expert system was developed in Shanghai, China for the early warning of brown planthopper outbreaks infesting rice cultivation[8].

Farm operations

- Autonomous vehicles or *robots* can perform labor-intensive tasks like harvesting crops, planting seeds, and monitoring fields. In USA, while a company in Denver, Colorado makes robots that identify and pick ripe fruits on farms, another in Livermore, California, develops smart tractors for dairy farming or loading or landscaping addressing the challenge of labor shortage[9].

Advisory services

- *Natural language processing (NLP)* enables computers to interpret and understand human language. It uses virtual assistants or chatbots to provide real-time advice in different languages on crops, pest control, and weather forecasts[4]. These are particularly useful in remote and inaccessible areas. Chatbot imitates human speech and responds to user questions via text or voice chats, by using AI and NLP technologies. NLP-based chatbot have conversations with farmers in an informal way and provide personalized advice in real-time through messaging apps, websites, and mobile apps[10].

SDG 3: AI for good health outcomes

SDG 3 has contributed to global health outcomes, with a 14% decline in maternal mortality ratio, and a 16% drop in infant mortality rate between 2015 and 2023. However, challenges related to inequalities and unaffordable health costs still exist. Globally, about 4.6 billion people lack access to essential healthcare services[11]. AI can accelerate SDG 3 by facilitating early detection of diseases with high accuracy, optimizing resource allocation, facilitating remote care, and hence improve healthcare service quality and efficiency.

Disease diagnosis

- *ML algorithms* process patient data to develop personalized and improved treatment plans and outcomes. It enables precise disease diagnosis, customized treatments, and detection of changes in vital signs, indicating potential health issues. For example, ML algorithms used for breast cancer diagnosis and treatment are logistic regression (LR), random forest (RF), and K-nearest neighbors (KNN)[12].
- *AI powered computer vision systems* interpret medical images such as X-rays, CT scans, MRIs, and pathology slides to identify abnormalities[13].
- Google's DeepMind developed the AlphaFold AI model that helps to predict protein-molecule structures accelerating drug development and improving understanding of genetic diseases and cancer[14].

Patient advice

- *NLP* helps in extracting insights from clinical data and improve diagnostic accuracy, streamlining clinical processes to enable personalized patient advice and care. Large language models like generative pre-trained transformer (GPT) models, for instance, are improved ML NLPs that help in generating human-like text by interpreting large datasets[15].

Surgical assistance

- *AI-powered surgical robots* assist surgeons in performing minimally invasive procedures with precision. The Smart Tissue Autonomous Robot (STAR) developed by Johns Hopkins University, for example, performed intricate bowel anastomosis by reconnecting two ends of the human intestine[16].
- *RL algorithms* enable surgical robots to learn and optimize surgical movements through simulation, feedback, and past surgical outcomes. Imitation learning allows robots to replicate demonstrations by expert surgeons.

and improve performance progressively. In surgical procedures like joint replacement, RL-driven robots can dynamically adjust implant positioning as per individual bone density, helping to minimize complications like implant misalignment[17].

Pandemic management

- AI-powered models were used during the COVID-19 pandemic. Enhanced epidemiological modelling predicted virus spread by collaborating ML and Deep Learning (DL) techniques, as well as supported clinical trials and vaccine development[18].

Telemedicine

- AI integration into telemedicine enables remote diagnosis, personalized consultations, and chatbot-based patient engagement, etc. AI-based medical chatbot PROSCA (PROState cancer Conversational Agent), for instance, is used to provide information on prostate diseases, diagnostic tests and treatment options[19].

Hospital management

- AI applications are also used for streamlining administrative tasks, optimizing patient data and inventory management, and improving patient flow in hospitals through predictive analysis. For example, ClinicalBERT designed for NLP in medicine, is trained in clinical notes and electronic health records[19].

SDG 13 and climate resilience

AI is a critical enabler for SDG 13 by optimizing the use of renewable energy, improving climate modeling to determine its impact, and forecasting weather advisory or early warning for severe weather events or natural disasters.

Optimize renewable energy deployment

AI-based predictive models enhance the resilience of energy systems by enabling grids to anticipate and respond to climate disruptions and natural disasters. By supporting smart grids with real-time monitoring, performance support, and anomaly detection, AI applications facilitate timely interventions, optimize resource allocation, and enhance grid stability[20]. This reduces downtime and operational costs, while improving the efficiency of low-carbon, renewable energy systems, critical for climate action. AI enables decentralized energy integration by optimizing microgrids and energy storage for efficient renewable energy generation[21]. Some related applications include:

- DL and RL help in optimizing energy production, improving storage and grid stability.
- AI tools, like genetic algorithms, bayesian networks, and digital twins, are used in addressing issues related to renewable energy systems.

Weather and climate forecasting

AI is widely applied in weather and climate prediction. It enables early disaster warning systems, and supports disaster response and recovery. AI-driven meteorology is a decision support system that integrates multiple AI agents, such the following:

- Vision language model (VLM) to interpret outputs and observations (radar and satellite imagery)
- Fine-tuned large language model (LLM) for drafting weather bulletins
- A retrieval-augmented generation (RAG) agents to incorporate protocols and historical context[22].

There are several AI-driven global weather prediction models that are efficient, accurate, and use minimal computational resources. For example, the US National Oceanic and Atmospheric Administration (NOAA) has developed a new suite of AI weather models which includes three distinct applications: AIGFS (AI Global Forecast System), AIGEFS (AI Global Ensemble Forecast System), and HGEFS (Hybrid-GEFS) [23]. They provide accuracy for large-scale weather events, and quicker delivery of forecasting services to meteorologists and the public.

It must be noted that AI-based weather advisory systems support farmers, including women farmers and those working in ecologically sensitive and inaccessible regions, by providing access to updated weather information for climate-smart farming practices[21].

Summary of AI applications

Various applications of AI, as discussed in sections 3.1-3.3, can be categorized as basic (involving low cost and infrastructure) and advanced (data-intensive, high cost, and technology-driven) (Table 1).

Table 1: Summary of evidence of basic and advanced AI-driven technologies and their applications in agriculture, health and climate initiatives

AI applications	Basic	Advanced
Agriculture application (SDG 2)	● Mobile-based AI advisory platforms Example: Plantix AI app (India) ● Smart irrigation solutions like solar-powered drip systems Example: NetBeat (India and Kenya)	● AI-powered tractors, drones, etc. Example: John Deere's autonomous tractors in the USA, Germany, and Finland ● ML models predict optimal planting and harvesting times Example: Climate FieldView (Canada, USA, European countries)
Healthcare management and diagnostics (SDG 3)	● Robotic Process Automation (RPA) for data entry, scheduling, and billing. ● Chatbots for basic conversational AI for patient screening, answering questions, and providing medication reminders. Example: Ada Health (Germany/Global); Woebot Health (USA); ZyE (India)	● ML algorithms to predict patient outcomes, optimize treatments, and identify disease patterns (precision medicine). Example: Bernoulli Naive Bayes (BNB), K-Nearest Neighbors (KNN), Decision Tree, etc. [24] ● AI-assisted robotic surgery to enhance precision in surgical procedures. Example: ROSA (Robotic Surgical Assistant) Knee System (USA/global); Toumai® endoscopic surgical robot (China)
Climate action (SDG 13)	● SMS-based weather advisory services provide real-time climate alerts Example: mAgri (Botswana, South Africa and other SSA countries) ● Forecasting project for solar and wind energy generation; optimizing renewable energy deployment in regions with diverse energy sources Example: RENAI project by SoftBank (India)	● AI-powered weather prediction models provide real-time climate forecasts Example: IBM Watson decision platform for agriculture (USA and Canada) ● Forecasting models predict solar and wind energy outputs Example: DeepMind's wind power forecasting (USA) ● Smart grids reduce losses and manage resources effectively Example: TenneT's smart grid management (Germany/ The Netherlands)

IV. Downsides Of Using AI

While it holds great potential, AI applications can be linked to several downsides like data quality, availability and reliability, workforce readiness, and cybersecurity issues. Also, ethical and societal considerations like data privacy violations, equity, and concerns about job displacement may come in the way of socially acceptable AI adoption.

Agriculture: In developing countries, farmers may lack access to technology and necessary infrastructure. Limited data accessibility and internet connectivity, varying levels of digital literacy, lack of skilled workers, high costs of digital infrastructure, and ethical concerns are the possible barriers to successful AI integration in agriculture[25].

Healthcare: Building trust and acceptance, deployment in actual clinical practice, disruptions in work practices during adoption of AI, and ensuring funding in public hospitals, especially in developing countries. AI brings several apprehensions like its overreliance leading to deskilling medical professionals, replacing healthcare staff and jobs, data quality issues, cybersecurity, and misdiagnosis.

Climate: Unreliable internet connectivity, limited computing power, high implementation costs, and lack of access to refined climate data (needed for training AI models and data-driven decision-making), are common in developing countries[26]. Evolving AI technologies create risks related to inaccurate results and cybersecurity. In addition, AI models consume large amounts of fossil-fuel-based electricity, contributing to emission of greenhouse gases, posing a climate change challenge. Also, the functioning of AI data centers relies on water for cooling, putting pressure on already stressed water resources. It also creates a link with climate change, as rising temperatures both increase cooling demands and intensify water shortage.

V. Cross-Cutting Challenges And Considerations

When biased data is used to train AI models, inequity can be a major drawback due to pre-existing, technical, and emergent **biases** related to social inequalities, gendered assumptions in design choices, and emerging knowledge forms. This gets further complicated by a data crisis driven by incomplete, non-disaggregated, and fragmented datasets[27].

AI-driven surveillance and data collection threaten **data privacy** and may impact human rights. There are various privacy concerns and uncertainties about how AI systems controlled by private and public entities can take personal data from users, and use or share it either intentionally or unintentionally, without the informed consent of the user.

There is **uneven access** to AI technologies driven by limited infrastructures, data systems and technical expertise in developing countries that deepens the divide between developed and developing economies (Table 1).

Research shows that in many regions in the world, **women** have lower chances of owning a mobile phone, internet connection, bank account, or credit and technology services, and have inadequate access to digital literacy resources. Only 20% women used the internet in low-income countries in 2023[28]. However, encouraging examples can also be found like the Accelerating Business to Empower Rural women in Agriculture (ABERA) generating practical models and guidance for women farmers in low-income countries to enhance their livelihoods and resilience to climate change[29].

AI's **environmental footprint** is another concern. As mentioned earlier, training large AI models and data centers consume substantial energy, contributing to carbon emissions, conflicting with sustainability goals. AI data centers consume natural resources like large amounts of freshwater for cooling and rare earth minerals for infrastructure[30].

Regulatory frameworks governing AI development and use are underdeveloped, creating risks of misuse and unethical deployment.

Therefore, AI applications must be well regulated and monitored well, and must be equitable, accessible, and ethical in all aspects[31].

VI. Conclusion And Recommendations

Climate change (SDG 13) acts as a cross-cutting stressor that impacts agricultural systems (SDG 2) and human health (SDG 3), while nutrition and health outcomes remain interdependent. Climate-resilient adaptation strategies can reduce climate vulnerability, reinforce food security, and improve public health, strengthening outcomes across all three SDGs. Figure 2 presents a conceptual framework for AI-enabled integration of three interlinked SDGs thereby addressing the related global challenges of agriculture, health, and climate change. While AI has delivered tangible benefits in advancing specific SDGs, its potential must be balanced against social and ethical risks, issues of inequality, and related environmental costs. This paper synthesizes evidence and draws meaningful connections across disciplines. The research process involved an integrative learning process, strengthening knowledge of complex global challenges and highlighting the importance of evidence-based solutions. However, the study is subject to limitations, including the absence of actual user studies, direct feedback from users about stated AI applications, and direct user input and insights. Future research should address these gaps by applying specific AI use cases for these SDGs, and incorporating users' perspectives through a combination of subjective and objective evaluations.

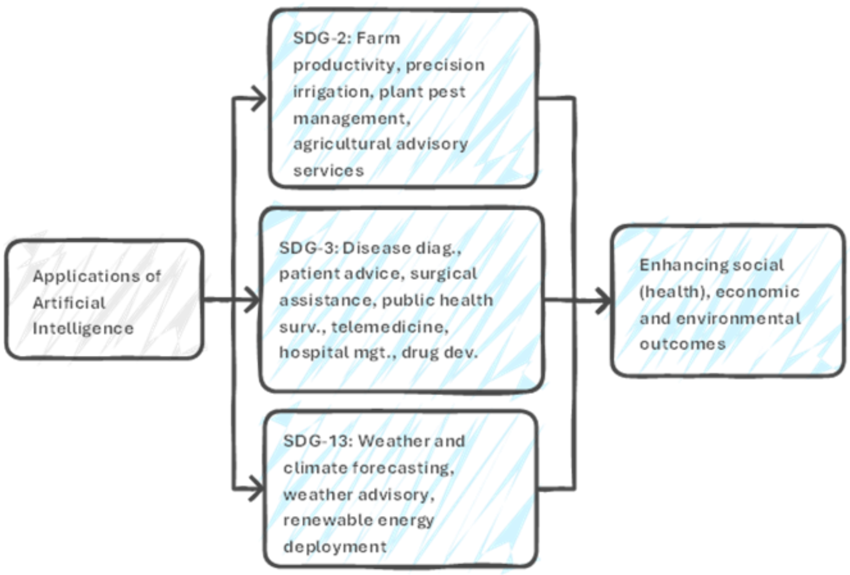

Figure 2: Conceptual framework for AI-enabled integration of three interlinked SDGs

An accountable, equitable, and sustainable AI system will enable technological innovation and lead to the implementation of the 2030 Agenda. Based on the UNESCO's code of ethics of AI[32], a set of recommendations on its responsible use for accelerating progress of SDG 2, SDG 3, and SDG 13 are summarized below (Table 2).

- **Ethical use**: The design, development, and use of AI must be conducted in an ethical and accountable manner. AI systems must consider human rights, follow legal norms, prevent unwanted harm to individuals or population groups, and align with social values.
- **Fairness and non-discrimination:** Social justice, fairness, non-discrimination, inclusivity, and accessibility must be promoted at every step, including low-income and developing countries, marginalized groups (marginal farmers), population groups living in geographically disadvantaged or inaccessible regions, and disabled individuals.
- **Gender responsiveness:** Gender biases in AI originate from conventional representations within communities. Gender-responsive strategies will ensure that women are represented equally in both the design and use of AI.
- **Privacy and data protection:** Privacy of users must be protected throughout the AI application and use process through adequate data protection plans.
- **Transparency and explainability:** Ethical AI systems largely depend on transparency and explainability of applications to validate AI-driven decision making.
- **Awareness and literacy:** Public knowledge and understanding of AI must be strengthened through accessible educational resources in local and understandable language, improved digital literacy tools, and training on AI skills and ethics.

Table 2: Recommendations on responsible use of AI for accelerating progress of SDG 2, SDG 3, and SDG 13

Theme	SDG 2 (Agriculture)	SDG 3 (Health)	SDG 13 (Climate)
Ethical use	AI-driven advisories must promote sustainable farm practices (minimal chemical use, optimize irrigation)	Ethically designed AI systems in diagnostics/ telemedicine must prevent: i) unintended harm to patients, ii) overdependence on AI tools (must augment and not replace expertise of medical professionals)	AI-driven transparent climate modelling by using ethical data and socially equitable instruments will enhance climate adaptation and mitigation strategies
Fairness and non-discrimination	Simple AI tools functioning in local languages and with low bandwidth/ offline mode can help smallholder farmers access advisory services, finance/ market solutions, etc. to help improve productivity.	- AI-based healthcare platforms will expand equitable healthcare access for all, - AI systems in rural medical facilities (underserved areas) can improve efficiency and quality - New AI tools can enhance patients' affordability of healthcare access and reduce hospital care costs.	Community-based data & indigenous knowledge must be integrated into AI-based climate models, making it a localized and fair approach to climate prediction.
Gender responsiveness	AI-based mobile apps and services must encourage its use by women farmers to access information on best farming practices, weather forecasts, credits, and market prices	Health equity must be promoted through bias-free AI datasets for equitable diagnosis. Datasets must focus on women's representation, leading to improved health outcomes.	Climate change disproportionately affects women, aggravating pre-existing inequalities. Gendered vulnerabilities must be identified through gender-sensitive climate data collection and development of inclusive AI tools.
Privacy and data protection	Protecting farmers' data from misuse by private /public entities is imperative. AI providers must ensure data transparency and obtain consent from farmers to collect, use, share and disclose data through agreements written in simple and understandable language.	AI-based digital healthcare depends on large datasets; patient data privacy through compliance with data protection laws is crucial to maintain trust in AI-driven healthcare systems.	AI-based climate data collection systems must ensure community and personal rights to privacy and clear consent mechanisms, as applicable.
Transparency and explainability	AI-based recommendations (advisories on pricing, crop selection) must be transparent and well-explained, providing actionable insights for farmers.	Clinical AI tools must be transparent and well explained to medical professionals to ensure safety, foster trust and validate decisions.	Transparency in AI-driven data usage policies is essential. Benefits derived from AI analysis (early warning, resource allocation) must be shared and explained to data-contributing communities.
Awareness and literacy	Farmers must be adequately trained for use and adoption of AI-based support systems (precision agriculture, weather forecasting, market access)	- Training and acceptance of AI tools among healthcare professionals must be ensured. - Patient awareness must be built to effectively engage with AI-enabled diagnostics and telemedicine.	Climate/AI literacy and awareness must be created among policymakers, communities and practitioners.

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