European Journal of Artificial Intelligence and Machine Learning
Vol 5 | Issue 2 | March 2026
ISSN 2796-0072

RESEARCH ARTICLE

Implementing Ethical and Responsible AI in Agricultural Practices: An Applied Perspective

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ABSTRACT

Farming is experiencing a shift in Artificial Intelligence (AI), opening its doors to precision farming, improving method for disease tracking, and providing smarter management of agricultural resources. Despite this new wave, it is also accompanied by sets of ethical questions regarding transparency, fairness, and privacy of data. While these questions are debated in industries, the focus has not shifted to how the principles play out in the fields. This study aims to determine whether global and regional AI frameworks truly fit the needs of agricultural farmers and users, and seeks to determine how knowledgeable farmers, researchers, and developers are about ethical AI. To obtain a clear understanding, a mixed approach of reviewing existing works and conducting a survey with AI professionals and agricultural workers was adopted. The results from the study proved to be a wake-up call, with over half the audience surveyed not being familiar with ethical AI concepts and only about 28% knowing about any actual regulations or policies of AI. Despite this, there was general agreement that the burden of ethics is not on one person but on everyone involved in the development, legislation, and farmers who use the tool. In addition, areas such as China, the UAE, and the EU, which adopted AI frameworks early, based on the findings, showed that they gained traction in agricultural innovations. The study concluded by suggesting that better policy outreach through education and cross-field collaborations would enable AI to support sustainable farming and protect farmers rights.

Keywords: Agricultural innovations, AgriTech stakeholder awareness, ethical AI.

Submitted: January 20, 2026

Published: March 20, 2026

10.24018/ejai.2026.5.2.70101

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1. Introduction

Great potential is being shown by artificial intelligence (AI) especially in changing the face of traditional farming, with sophisticated tools like machine learning and deep learning, detection of early plant diseases is now possible. These intelligent systems can analyze a large amount of agricultural data while understanding patterns and developing insights that can help farmers obtain better yields and grow healthier crops. However, despite the progress made by these systems, they have not yet taken over a larger part of the industry. The major reason is that AI models and tools are seen as "black boxes" that cannot be explained with ease to the farmers, and this gap creates a lack of trust, hindering them from bringing these tools to their daily routine.

While still growing and developing at an accelerated pace, AI has already augmented human life. This technology is now increasingly commonplace in our homes, workplaces, travels, healthcare, and schools. What would have seemed like science fiction just two decades ago (such as a phone detecting the exact disease a plant has and virtual personal assistants) is set to become a fixture of our daily lives [1]. As AI becomes more integrated into our lives and its role in decision-making in different industries expands, more ethical issues and concerns are becoming apparent. Primarily, the role of AI is to be of great interest to people and organizations and positively impact them, not the other way around. Many artificial intelligence techniques have already been applied to agricultural tasks, such as the use of self-learning systems for large-scale crop harvesting, precision agriculture to aid in the detection of

plant diseases, soil monitoring, animal disease diagnosis, and Internet of Things (IoT) devices, which refer to the idea of connecting physical objects to the Internet to enable remote control and monitoring. As noted by Okengwu *et al*. [2], artificial intelligence (AI) is a powerful tool that can help manage the negative impacts on the environment more effectively by minimizing ecosystem damage and preventing further harm.

Developing responsible AI creates huge potential for strengthening key sectors, with agricultural systems becoming more people-focused, resilient, sustainable, and equitable. It is important to note the base reason for this intelligence, which is to empower the experts without pushing them off the picture; the human touch should be preserved at the heart of farming. To fully harness AI's capabilities of AI in agriculture, interdisciplinary cooperation, maintenance of ethical standards, and safeguarding of farmers rights should be the top priorities [3]. In line with these, Okengwu *et al*. [4] examined the viability of AI tools and technology in crop management by using this tool for the classification of tomato leaf diseases. Their work was more focused on the detection of diseases in plants, giving limited attention to the issues of fairness and accessibility, especially how smallholder farmers in low-resource environments would afford this tool. This limitation brings to the fore the argument that AI advances need to be closely aligned with the ethical principle of equitable access for all and inclusion. Han and Sun [5] covered the Yangtze River Economic Belt between 2011–2023, studied how AI is shaping and realigning the future of eco-friendly farming. The authors proved, despite several trials, that incorporating AI into agriculture greatly enhanced green development. This AI advancement could have a ripple effect from a local district to neighboring areas, improving environmental performance in farming.

There has been a shift in Responsible AI concerns, which now pertains to ethics, social and human consequences. Which initially pertained to AI development, implementation and deployment of these AI systems. Responsible AI handles and considers fairness, accountability, and transparency which are ethical values during the development of AI tools and applications. These tools and applications developed must be devoid of algorithmic bias, privacy infringement, and supports equity, human rights, and societal wellbeing are the main criteria to be considered responsible. While these criteria require more than just technical solutions (explainability and data security), it also requires a firm governance structure that offers oversight and stakeholders' involvements in a meaningful manner. Besides these requirements, responsible AI development also requires considering socio-economic implications of AI development critically, including its implications for the labor force and agricultural livelihoods. When these ethical factors are totally considered, the AI tools are used responsibly. Hence, shifting from the abstract idea of AI into a better practical approach, which would gain trust and ensure a sustainable and equitable development from this technological advancement. Artificial intelligence can be of various forms, from software and algorithms to a physical form, like a farm machine, drones, cars, and even robots. It becomes necessary for us to make a distinction between the technology that actually uses AI and the technology that only uses automation. Generally, it has been noted that not all robots and programmed systems actually portray intelligence. This is because most of the 'robots' only work through a set of instructions, either through human control or with a very limited level of autonomous control. Ryan [6], makes a clear distinction between rule-based machine designed for specific task, industrial robots and more advanced robots that can employ intelligence artificially to learn, adapt and make decisions within a changing environment in his work "The social and ethical impacts of artificial intelligence in agriculture: mapping the agricultural AI literature,". Within the agricultural context, this distinction is crucial as it helps AI researches and discourse to focus on tools and systems that demonstrates adaptive intelligence rather than just traditional farming machines. Accordingly, this paper is concerned only with devices, programs, and applications that incorporate some degree of artificial intelligence, whether in decision-making, prediction, or autonomous operation.

2. Ethics and Responsible AI

Currently, AI is used in agriculture to increase production, sustainability, and efficiency. This translates to ethical and responsible AI concepts becoming increasingly important. While the models and capabilities used in AI food system technologies may, in many cases, be of a different kind than the ones gaining the most exposure in media and public discourse, trust is all the more essential for agriculture and food system technologies, given food's pervasiveness and significance to human life [7]. For ethical or regulatory frameworks to be effective in facilitating trust, an important first step is to identify who is responsible for identifying ethical concerns, developing ethical frameworks, and implementing them in practice. By putting these questions in context, we aim to see how these ideas work in the field of agriculture.

One challenge that arises with the development of artificial intelligence (AI) for agriculture is ensuring that the emerging system behaves responsibly. Buchholz *et al*. [8] addressed the importance of responsibility in the context of artificial intelligence (AI) in manufacturing and presented a methodology for implementing these concerns in an AI development project. They started by pointing out that while many theoretical frameworks and methods are available to handle accountability concerns within AI environments, the implementation of these frameworks within project development remains obscure. We now attempt to determine how these principles would be implemented in the agricultural space.

2.1. Fairness and Equity in Agriculture

AI tools and systems are progressively being deployed and used in agriculture for activities such as crop monitoring, yield prediction, and resource management. However, since 'fairness' within the food industry cannot be explicitly defined, Prete and Samoggia [9] idea of fairness within the agricultural sector is a changing definition over time.

Research has shifted to look at these issues from the farmers point of view when discussions of fairness, ethics, and justice are being considered as if they all mean the same thing. Fairness is observed when small-scale farmers can access AI tools and benefit from whatever they offer while operating without bias, treating all farmers equally rather than selectively favoring certain individuals or regions.

2.2. Transparency in AI Agricultural Tools

It has proven necessary for farmers and all stakeholders within the agricultural industry to understand how AI tools propose suggestions on choosing which crop to plant, how to tackle pests and diseases, or the timing of irrigation. It cannot be denied that AI and machine learning have a massive advantage in prediction of what comes next, but these do not come without hurdles. This is why developers of these tools need to deviate from technical jargon and offer plain explanations of how their systems arrive at their conclusions. Many end users of this technology are not experts in the underlying code; hence, transparency is very important. When developers are open about the data used and the logic backing the algorithms, it does more than make the process clear; it builds trust and confidence in the users, who are the farmers, and helps them make better judgment calls on the farms.

2.3. Accountability for AI Impact

Anyone involved in the development, implementation, or deployment of AI tools and systems in agriculture should take full ownership of how these systems perform and the impact they create when used. AI sits at the intersection of computer science and several other fields where it is deployed, and clear accountability is important. Alexander *et al*. [10] pointed out how developers own the responsibility to handle issues such as data bias, data privacy, and data security, and how they ought to put in proper safeguards and corrective measures so problems can be corrected when errors occur.

2.4. Privacy and Data Protection

AI systems do not possess moral judgement because they are solely built to support human goals and automate human activities without human intervention. Gardezi *et al*. [11] acknowledge that AI and big data are being used to gather, process, and analyze information within the agricultural sector, raising concerns about data protection and privacy. Many farmers and users of these AI tools remain unaware of who would be held accountable if their data are misused, making transparency and fairness essential to earn their trust. Farmers Privacy should be prioritized in all responsible data practices, and these practices should comply with existing data protection laws. Important steps, such as encryption to protect sensitive information, anonymizing data, and ensuring secure storage, play a key role in reducing privacy risks and fostering trust between users and developers.

2.5. Societal Well-Being

Mana *et al*. [12] noted that a large number of people between 720 and 811 million are still suffering from food insecurity globally, and modern farming that ought to be the solution is hitting more hurdles when it comes to keeping up with production and oversight policies. This is a clear picture of how urgent it is for us to begin moving towards automation and re-writing our existing systems. To deliver a sustainable agricultural system that can confidently handle over 10 billion people on the planet by mid-century, immediate action should be taken. Rist *et al*. [13] noted that technological innovation plays a vital role in increasing general ecosystem productivity and supporting long-term human development.

Moreover, AI has proven to have immense potential for better resource utilization and minimizing environmental damage. In addition, agricultural systems have enhanced resilience to withstand climate change and other risks by using AI responsibly. Aijaz *et al*. [14] pointed out that real-time data collection is the foundation of AI decision-making. This helps farmers to optimize fertilizer and pesticide usage, and thus better utilize resources. As technologies are continuously developed using the framework of responsible AI, as shown in Fig. 1, it is evident that these technologies are no longer limited to enhancing efficiency and productivity. They also play a critical role in enhancing the application of ethical principles. This includes aspects of fairness, transparency, and sustainability to ensure that critical challenges in the agricultural sector are addressed while ensuring positive outcomes for farmers and the environment as a whole.

3. Ethical AI Adoption: Current Practices and Challenges

In 2019, the Organization for Economic Cooperation and Development (OECD) and its 42 partner nations agreed to uphold international standards aimed at ensuring that AI systems are designed to be reliable, safe, equitable, and trustworthy. This was reportedly the first set of intergovernmental policy guidelines on artificial intelligence [15].

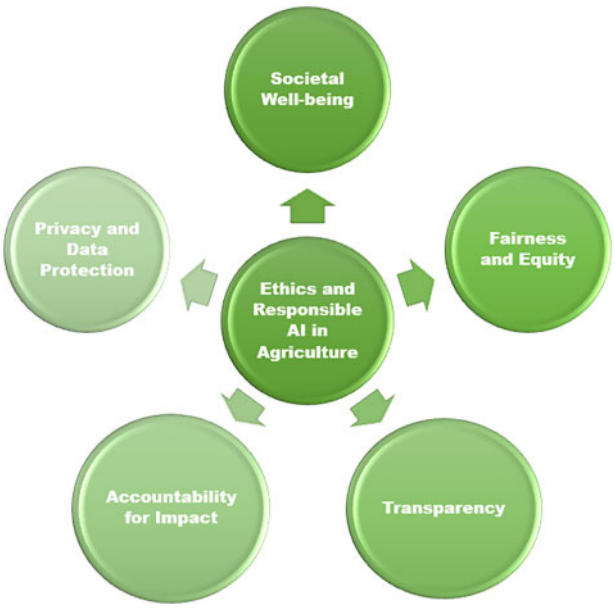

Fig. 1. Ethical and responsible AI principles.

TABLE I: Countries and AI Policies Adoption Year

Country	Adoption year	Policy title
United State	2023	Federal Artificial Intelligence Risk Management Act
European Union	2021	EU Artificial Intelligence Act
China	2017	New Generation AI Development Plan
Canada	2022	Artificial Intelligence and Data Act (AIDA)
United Kingdom	2019	AI Ethics Guidelines and Strategies
Japan	2019	Social Principles of Human Centric AI
UAE	2017	UAE Strategy for Artificial Intelligence
Kenya	2018	Emerging Digital Technology for Kenya
Mauritius	2018	Mauritius Artificial Intelligence Strategy
Egypt	2021	Egypt National AI Strategy

Gurría [16] noted how artificial intelligence is transforming our way of life and work while also having a huge positive impact on our economy and society. He further pointed out how technology creates new difficulties and stokes worries about morality. According to him, 'this places the onus on governments to make sure that AI systems are designed in a way that respects our values and laws, so people can trust that their safety and privacy will be paramount.'

There are no specific AI rules or regulations worldwide. Rather, several countries and regions have adopted different approaches to controlling the development and implementation of AI technology ethically and responsibly. Data protection, transparency, and the overall effect of AI on jobs and security are major issues for countries. To ensure the ethical development of AI and its global implementation in some capacity, cooperation is essential [17].

Considering the strategies that various countries are employing to implement their national AI policies, we sneak a peek through a crystal-clear window to see how government stakeholders are dealing with the growth of AI. While developing AI policy documents, it is not just a list of dos and don'ts; it also shows what each country cares about. Whether it is winning the race of technological advancement, economic growth, or just ensuring that guardrails and sustainability laws are placed at the heart of development. By examining how and when these strategies are developed, we can observe trends, quirks, and differences that occur worldwide and even regionally to ensure that everything is kept under regulation. To facilitate visualization, Table I and Fig. 2 present a timeline of the evolution of AI governance from 2017 to 2023 across ten countries. It also examines how the world of AI governance has been moving in regions and how it has shifted within just a few years to ensure that policy goals are met.

AI policies are now starting to look very different from one region to the next across the world, due to the fact that every region has its own set of priorities and a unique way of handling regulation. The United States does not have an all-encompassing federal law for AI; rather, the government is tackling it one by one. This is done using specific rules for different sectors, such as health, agriculture, and finance. One big move that has happened recently is the 2023 Federal Artificial Intelligence Risk Management Act [18], which was created to guide government agencies on

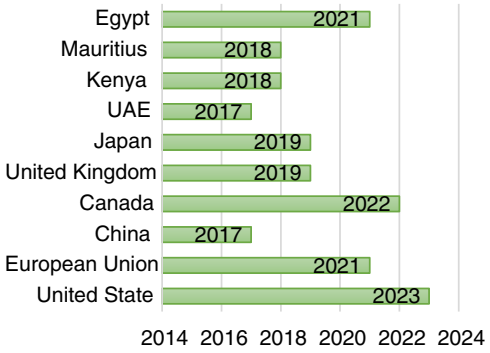

Fig. 2. Countries' AI policy adoption year chart.

firm standards for testing and double-checking AI systems before deployment to the general public. State-level activities, such as the "California Privacy Law", continue to play a vital role in shaping how data-driven AI tools are developed and deployed to users.

The European Union took a different route when it rolled out the AI Act in 2021 [19]. It set up a regulatory framework with the goal of ensuring that AI systems, when developed, do not just act as black boxes but show a good level of transparency, traceability, and fairness. The need for compliance and assessment of the data used has made the EU take the blueprint of the GDPR and upscale it. The EU intends to achieve a delicate balance that allows technology more room for growth without compromising individual rights and developer accountability.

In 2017, instead of waiting, China decided to take a very clear goal and started by launching the New Generation AI Development Plan to enable them to lead the world in AI by 2030. The broad strategy touched on all aspects, including data security and the rules and ethics of using AI. According to Sheehan [20], the Chinese mission is to find developers who can interpret the cover of their algorithms. This is to ensure that the government and the general public have a good understanding of how these systems make decisions and the data used. Within the same year, the United Arab Emirates joined China with the 2017 Strategy for Artificial Intelligence [21], which was a critical part of their "UAE Centenary 2071" vision. Focusing on the bigger picture of diversifying their economy and ensuring their workforce is ready for the future, they chose not to put much emphasis on the code used in developing these tools. They are actually betting big on AI to have a huge impact on the basics of life, healthcare, transport, energy,

and farming. Together, these countries show a proactive, innovation-first model of AI governance.

Later adopters of national AI policies placed a much higher emphasis on ethics and public trust. In 2019, the United Kingdom sought out individuals in the AI development cycle to actively address ethical concerns with the release of the AI ethics handbook [22] to ensure governance throughout the project lifecycle. In the same year, Japan introduced its "Social Principles of Human-Centric AI" [23], which was a framework built with the idea of sustainability, diversity, and fundamental respect for human dignity. The goal was to develop a set of rules that ensures AI advances in a way that reflects social values instead of jumping into rigid laws. This is part of the OECD's global drive for inclusive development. However, Canada has adopted a more structured approach to the development of its Artificial Intelligence and Data Act (AIDA), introduced in 2022. This is to closely monitor highly impactful AI systems. Hence, it is necessary to encourage better accountability and prevent harm before it occurs. Brandusescu and Sieber [24], while critiquing the process, noted some of the major checks of reality. For example, innovation, although good, is not enough on its own. Perhaps the benefits of new technologies may not necessarily accrue to everyone.

Within Africa, AI has been positioned as a catalyst for socio-economic development. In Mauritius, in 2018, a strategy was developed that positioned AI as a new means of infusing life into local industries while also creating new opportunities for economic growth [25]. Around the same period, Kenya began taking its first steps towards creating a comprehensive AI strategy by forming its Distributed Ledgers and AI Task Force [26]. Egypt finally joined the discussion on AI when it launched its National Strategy, connecting AI to its ambitions of attaining sustainable development while improving partnerships in the region three years later [27]. Although they are serious about using AI to drive development, they still face challenges related to infrastructure and regulation.

When these countries are viewed comprehensively, it becomes apparent that there is an emerging trend. While countries like China and UAE, who were early movers, have demonstrated that they were only interested in ensuring they were competitive with a focus on rapid innovation. Countries like Japan and the UK, who came on board later, have moved towards ethical development with a focus on trust. The latest additions, like the EU, Canada, and the US, seem to be relying even more on regulatory clarity, which will result in better accountability as well as a better plan for risk management. On the other hand, countries in Africa seem to be highlighting the potential of AI in driving sustainability as well as socioeconomic development. The real-world benefits have been witnessed in countries that have adopted this technology at an early stage of the farming industry. By using AI for monitoring crops and for streamlining the supply chain, it gave them a good push forward in terms of yield and efficiency. Countries like Canada, the UK, and Japan have implemented a strategy on AI at the beginning of the 2020s. This helped them push their agricultural sector quite far into the future by using smart farming and data policy strategies. In the case of China, although the system was launched in 2017, some of the provinces, particularly in the Yangtze River Economic Belt, started using AI for monitoring crops and for pests and irrigation systems. By reviewing the data from the year 2011 till 2023 [5], it became quite evident that the system not only helped the local farming sector go green but also had a spill-over effect on the neighboring regions.

Similarly, the UAE has set an early pace in implementing its policy on artificial intelligence, thereby hastening the pace of precision and smart-farming. Concepts such as AI-based water management and intelligent greenhouses are becoming increasingly popular. This enables farmers to produce more agricultural products, even under unfavorable conditions, without wastage or unnecessary expenses. In this regard, the agricultural sector has demonstrated its resilience even in the face of serious challenges, such as climate change and food security. According to the Food and Agriculture Organization (FAO) [28], not only does the early implementation of AI policies encourages innovation and helps maintain the competitiveness of the respective countries. They will be able to address any future risks and ensure profitability.

4. Discussions

The aim of the questionnaire was to obtain an exact picture of how AI can be used in agriculture from an ethical perspective. For this, we largely depended on the opinions of industry experts who use these technologies. Their opinions proved to be of utmost importance understanding the sentiment of the people regarding artificial intelligence, the concerns people have regarding these technologies, and what they consider to be of utmost importance with regard to these technologies. The survey responses were voluntary and confidential.

Of all the respondents, the majority were farmers (42.7%), followed by researchers (31.7%) and technology developers (7.3%). All respondents were actively engaged in the integration of AI technologies in agriculture and had practical experience using these technologies. Fig. 3 shows a chart representing the respondents.

The data show the respondents' familiarity with the ethical considerations of AI technologies on a five-point scale, with five representing high familiarity. Fig. 4 shows that more than half of the respondents lack familiarity with these considerations and are therefore not likely to take them into account. Although policies on AI are being drafted and implemented in most parts of the world, the dissemination of such information is still required. This is

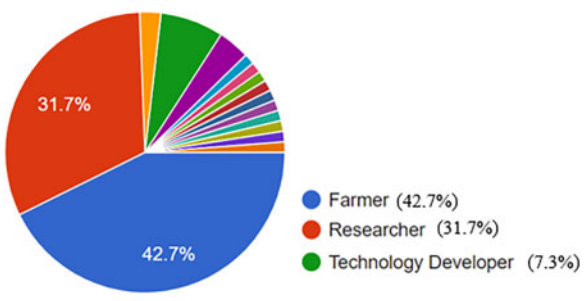

Fig. 3. Survey respondents demography.

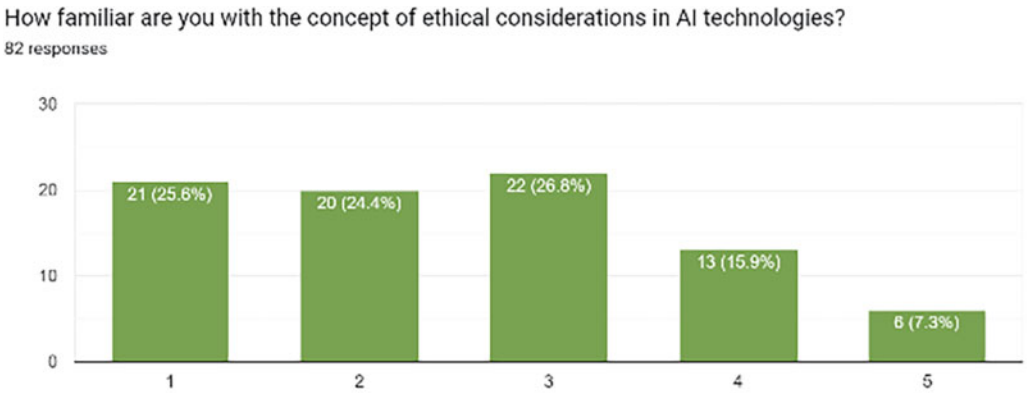

Fig. 4. Respondents' ethical considerations in AI familiarity chart.

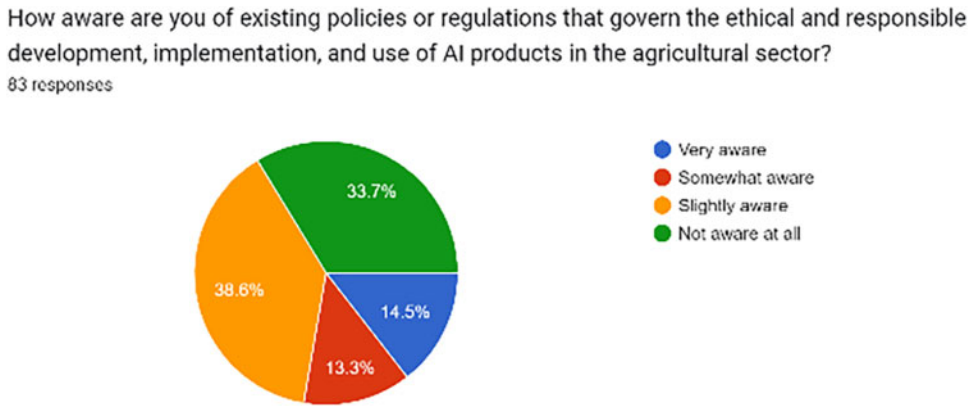

Fig. 5. AI policies and regulations awareness level.

supported by Fig. 5, which shows that 27.8% of the respondents are aware of AI-related policies and regulations.

This low level of awareness highlights a significant gap in knowledge among professionals, emphasizing the need for more comprehensive education and dissemination of information regarding AI-related policies and regulations in the healthcare sector.

The survey responses were diverse in terms of the respondents' views on the people responsible for the ethical use of artificial intelligence (AI) in agriculture as shown in Fig 6. A good number of the respondents supported the concept of collective responsibility of various people or entities in the use of artificial intelligence in agriculture. These people include AI developers, policymakers, agricultural institutions, and AI end users. A good number of the respondents were of the view that the developers of artificial intelligence and the institutions that use it are responsible for ensuring that it is compatible with ethical standards. However, policymakers were also instrumental in formulating policies and laws governing the use of AI in the sector.

The highlights point to several potential benefits that may be derived by the agricultural sector in the next five to ten years as a result of the application of artificial intelligence. First, there is an expectation that AI will greatly improve crop productivity in the agricultural sector. This will be achieved through the application of precision farming techniques, which will be made possible by the analysis of large amounts of data using AI systems. Second, AI is expected that AI will improve resource management in the agricultural sector. This will be achieved by applying AI to streamline logistics and deliver products to the market efficiently.

Overall, the respondents were positive, as shown in Fig. 7, that AI would not only improve agricultural productivity but also lead to more sustainable agricultural practices, which will be beneficial to both the agricultural sector and the wider economy in the long term.

Current survey results show continued optimism regarding the role of AI in transforming agricultural practices over the next ten years. In fact, a majority of those surveyed expect significant developments, as shown by 72% expecting crop yields to increase, 73% believing that food security will benefit from a significant boost, and over 70% expecting better resource usage alongside reduced labor costs. However, it is generally accepted that AI has much broader benefits than just increasing productivity, as it has the potential to ensure sustainability in agricultural practices. This has already been observed in precision agriculture, where decisions are based on data rather than conjecture. An excellent case in point is the work of Okengwu *et al.* [29], who created a method that allowed smartphones to run deep-learning models in realtime for crop diseases. This, in essence, shows that AI can be used ethically, as it does not require large budgets or infrastructure to be effective.

4.1. Gaps in Stakeholder Awareness and Underlying Causes

The survey showed a huge gap between stakeholders' awareness of some issues. In particular, those relating to ethical principles regarding AI and policy development.

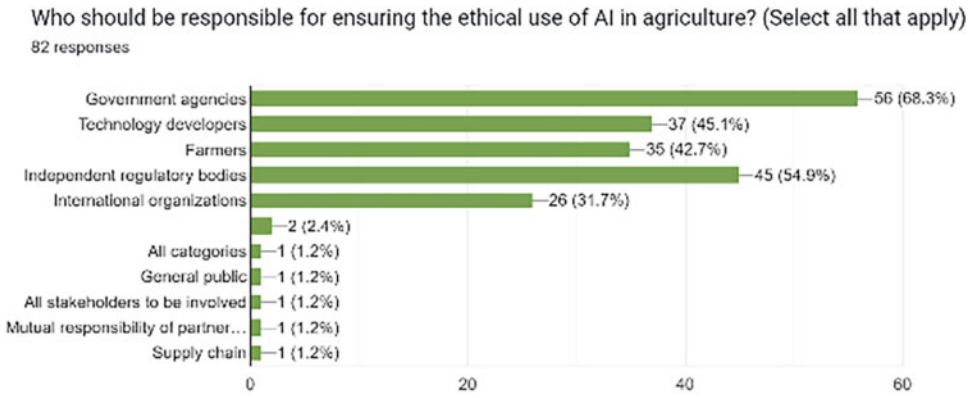

Fig. 6. Enforcing ethical use of AI in agriculture.

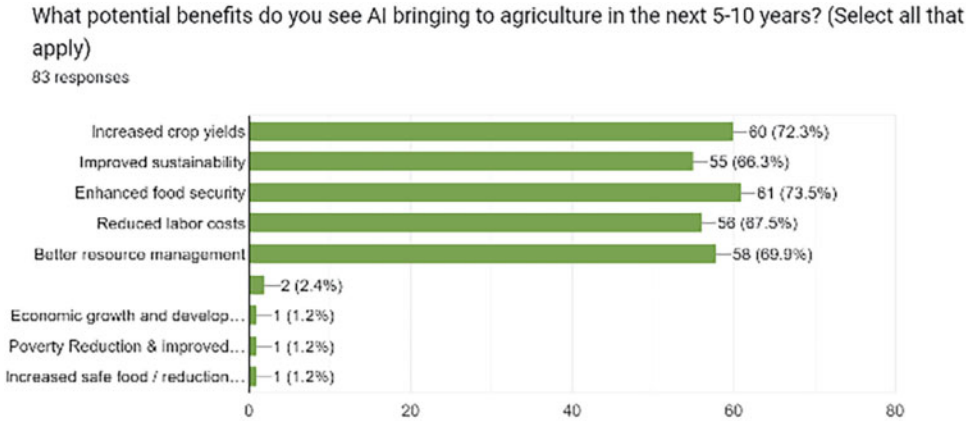

Fig. 7. Benefits of AI in agriculture.

The majority of those who took the survey showed a low level of awareness regarding ethical considerations, with only 27.8% revealing their awareness of AI regulations.

Several factors account for this variance. First, we have systemic barriers, which encompass the rollout of AI policy and a lack of engagement from extension services. This makes it difficult for stakeholders to access critical information. Second, infrastructural barriers encompass a lack of digital literacy and internet connectivity. This is especially true for the rural population, who find it difficult to access critical information regarding the complexities involved in ethical guidelines. Third, we have education and culture as factors. The majority of educational institutions only cover the 'how-to' part of AI, while the ethical part is glossed over. If a policy is poor, why bother following it? Finally, we have regions that encompass the EU's high regard for policy communication, while developing countries, such as those in Africa, have yet to come on board.

Several strategies can be used to bridge this gap. Some of these strategies could include developing an effective means of disseminating information, developing AI ethics in training farmers, and implementing awareness activities on a regional basis [30]. However, despite these challenges, it is crucial to identify strategies that ensure fair and responsible AI adoption in agriculture. AI can be utilized in several ways, such as for the monitoring and assessment of crops.

5. Conclusion

The main aim of this paper is to emphasize the importance of ethical and responsible artificial intelligence in the development and use of these technologies worldwide. By analyzing the development of AI policies in various countries worldwide, it can be understood that a major pattern emerges from the analysis. By developing and implementing AI policies, countries can reap major benefits, especially in the agricultural sector. Along with the benefits, the country would also be able to deal with the challenges that will emerge in the agricultural and food production sectors in the future. In the future, it is important to ensure the development of AI by incorporating the two aspects of ethics and accountability. By doing so, it would be clear that there would be significant scope for the development of the agricultural sector. At the same time, it ensures the well-being of people in the agricultural sector worldwide. By doing so, it would be possible to ensure the development of the agricultural sector through AI while simultaneously ensuring a better future for the people in the sector.

Therefore, further studies are necessary to determine the mechanisms for making AI accessible to smallholder farmers and to develop training programs for understanding ethical AI practices. Integrating AI ethics into agricultural extension services would help enhance transparency, equity, and accountability. This would not only instill trust among the stakeholders involved in agricultural development but would also ensure that AI contributes substantially to the development of agriculture.

Acknowledgment

We would like to express our sincere gratitude to the organizations that contributed to the successful completion of this research.

Scholarship funders—International Development Research Centre (IDRC) and Swedish International Development Cooperation Agency (SIDA)

Scholarship Programme—Artificial Intelligence for Development (AI4D) Africa

Scholarship Fund Manager—Africa Center for Technology Studies (ACTS).

Your support and contributions have been truly instrumental, and we are sincerely grateful.

Conflict of Interest

Authors declare that they do not have any conflict of interest.

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