Transforming Agriculture with Artificial Intelligence: The Role of Libraries in Meeting the Challenges of Food Security and Efficiency in the Fourth Industrial Revolution

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Abstract
This study investigates the impact of Artificial Intelligence (AI) on agriculture to address food security and efficiency in the Fourth Industrial Revolution, as well as the role of libraries in this transformation. The study adopted a descriptive qualitative approach using in-depth interviews. The study involved 30 experts in the intersection of agriculture and AI, with the data collection through in-depth interviews and thematic analysis. The study suggests that AI can significantly benefit agriculture by increasing efficiency, yield, and sustainability. However, there are also concerns about AI adoption in agriculture, such as job loss, data privacy, and ethical implications. The study highlights the important roles that libraries can play in supporting AI adoption in agriculture by providing access to critical data sets and resources, acting as a hub for collaboration and knowledge-sharing and connecting farmers with AI experts and technology providers. The study concludes by

suggesting several strategies for libraries to improve their services for agricultural researchers and practitioners working with AI technologies. These suggestions include collaborating with AI experts, developing tailored resources, providing personalized services, and offering training and workshops on AI technology. Finally, policymakers can take several actions to promote the responsible and sustainable adoption of AI in agriculture by establishing regulatory frameworks and ethical guidelines, investing in AI research and development, and supporting the development of AI-based agricultural systems.

Keywords: *Agriculture, Artificial Intelligence, Food Security, Libraries, Fourth Industrial Revolution,*

Introduction

The fourth industrial revolution (4IR) has brought about a transformation in the agriculture industry, aided by advanced technologies such as artificial intelligence (AI), according to a report by the World Economic Forum (WEF, 2018). AI has enabled the development of innovative solutions, challenged traditional farming methods, and increased efficiency. As the global population is projected to rise by 2050, the agriculture industry will face increasing pressure on land, necessitating innovative solutions to increase productivity and reduce waste (FAO, 2009). AI is emerging as a critical tool in achieving the objective of increasing global food production by 50% by 2050 to feed an additional two billion people (FAO, 2009). Libraries can play a crucial role in supporting the agriculture industry by providing access to relevant information and resources on AI and related technologies. By doing so, they can assist in meeting the challenges of food security and efficiency in the 4IR.

Over the years, AI adoption has increased user engagement in developed countries, providing timely information essential for efficient decision-making (Gyamfi et al., 2021). In agriculture, AI technologies can be used to optimize crop yields, reduce resource waste, and monitor soil health (Cioffi-Revilla 2020). AI-powered sensors can detect soil moisture levels, nutrient deficiencies, and pest infestations, and improve library services (Cioffi-Revilla et al., 2020). It has the potential to revolutionize the agriculture industry by improving productivity, reducing waste, and increasing efficiency. In Nigeria, agriculture is a critical sector of the economy, accounting for over 22% of the country's GDP and employing over 60% of the population (World Bank, 2021).

According to Ogunmodede (2019), libraries have come to be seen as the centre of development. It is crucial to achieving the objectives of sustainable development of meeting the challenges of food security and efficiency in the fourth industrial revolution. The library uses information as a resource to provide the goods and services that farmers and researchers require to meet some of these challenges. The library's

sole purpose is to gather, organize, and disseminate knowledge such as recent technologies like drones, and robots among others that can be used to meet food security challenges in the fourth industrial revolution. However, in Nigeria, the agricultural sector faces significant challenges, including low crop yields, high post-harvest losses, and limited access to finance and markets (IFPRI, 2013). The adoption of advanced technologies, including AI, is essential to increasing agricultural productivity and efficiency in Nigeria. Many farmers lack the knowledge, skills, and resources to adopt and utilize these technologies effectively, hindering their adoption and implementation.

Therefore, libraries have a critical role to play in the support towards the adoption of AI in agriculture by providing farmers with access to the latest research and information on AI technologies and their applications in agriculture. They can also serve as a hub for training and education on the use of AI in agriculture, providing farmers with the necessary skills to effectively utilize these technologies. Furthermore, they can collaborate with agricultural research institutions and industry partners to support the development and deployment of AI technologies in agriculture. However, the role of libraries in meeting the challenges of food security and efficiency in the fourth industrial revolution is unknown and also there are limited research has been conducted on the applicability of AI in the Nigerian agricultural context. It is against these backdrops that this study seeks to investigate the role of libraries in meeting the challenges of food security and efficiency in the 4IR using AI in transforming agriculture.

Objectives of the Study

This study aims to examine the role of artificial intelligence in transforming agriculture to meet the challenges of food security and efficiency in the fourth industrial revolution. The specific objectives are;

1. To assess the potential of AI in reducing resource waste and improving crop yields in agriculture in Nigeria;
2. To examine the current status of libraries in supporting the adoption and implementation of AI technologies in agriculture; and
3. To assess the effectiveness of existing library services and resources in meeting the information needs of agricultural researchers and practitioners working with AI technologies.

Literature Review

The 4IR is characterized by emerging technologies such as artificial intelligence, cloud computing, and robotics, which have the potential to deepen societal inequalities by widening the gap between developed and developing countries (Business, Society Conference 2018). However, understanding and appreciating the opportunities that come with this revolution can lead to significant improvements in people's lives (Lekhanya 2019). Smart production in the fourth industrial revolution will require new skills training, leading to a shift from intensive labour programs to

more efficient and intelligent methods (WEF 2018). The agricultural sector, being the least digitized industry, has seen tremendous growth in the development and commercialization of agricultural technologies, with AI playing a significant role in this transformation (Kakkad, Patel and Shah, 2019).

AI can analyze and interpret farming data to provide comprehensive information, promoting smart farming and increasing food production and security (Marucci et al. 2017). AI implementation in agriculture has revolutionized the modern agricultural system, resulting in increased crop production and real-time streamlining of harvesting, processing, and marketing (Yang et al. 2007). To ensure the digitalization of agriculture is effective, relevant human technical skills are required (Shaharudin 2019). According to Aubert et al. (2012), the use of AI in agriculture has increased significantly in recent years, providing farmers with adequate support when making decisions and other operations. AI-based technologies can help increase productivity in all areas of agriculture, including crop yield, irrigation, identification of soil content, monitoring of crops, weeding, the establishment of crops, and more. Kim et al. (2008) also stated that by automating various procedures and minimizing risks, AI can reduce the workload on farmers and increase the quality and quantity of farm yield.

One of the key benefits of AI in agriculture is its ability to process and analyze large amounts of data steadily and accurately. As reported by Liakos et al. (2018), AI can also outperform humans in detecting and diagnosing anomalies, such as plant diseases, and making predictions, including about yield and weather. Algorithms are already being used to regulate drip-irrigation grids, command fleets of topsoil-monitoring robots, and supervise weed-detecting rovers, self-driving tractors, and combine harvesters (World Economic Forum, n.d.). As a result, AI is being hailed as the way to revolutionize agriculture, with the World Economic Forum setting AI and AI-powered agricultural robots at the forefront of the fourth agricultural revolution.

Moreover, Panpatte (2018) explained that AI can also help in the area of food security, with nearly 598 million people suffering from hunger worldwide, and 39 million people, including 18 million children, food insecure in America alone. AI can help in streamlining responses to food insecurity by gathering and interpreting large amounts of data to evaluate areas of need, predict where and why hunger occurs, and efficient food distribution. By using AI and machine learning, organizations can quickly gather and interpret large amounts of data to address food insecurity stemming from the complex circumstances that lead to food insecurity in its many forms. Oyelade et al. (2021) developed a system that uses AI to identify and diagnose crop diseases and pests with high accuracy, reducing the need for manual inspection by farmers. Similarly, Zou et al. (2019) demonstrated that AI and machine learning techniques could

reduce water use for irrigation while maintaining crop yields, while Liang et al. (2020) used AI to optimize fertilizer application in wheat crops, resulting in increased crop yields and reduced fertilizer use.

However, as pointed out by Uyeh, Gebremedhin and Hiablie (2023), the successful adoption of AI technologies in agriculture in Nigeria is hindered by several challenges, including a lack of access to technology, insufficient technical knowledge, high costs of acquiring and maintaining AI technology, inadequate infrastructure, poor internet connectivity, and inadequate power supply. Policymakers should take into consideration these challenges and invest in addressing them to ensure that the potential benefits of AI in agriculture are realized in Nigeria. This could include measures such as providing training and support to farmers and agricultural experts, increasing access to technology, improving infrastructure, and reducing the costs of acquiring and maintaining AI technology. The role of libraries in supporting the adoption and implementation of AI technologies in agriculture has been the subject of several empirical studies. These studies have identified the challenges faced by libraries in providing access to the necessary resources and have suggested strategies to overcome these challenges.

One such study by Singh et al. (2021) explored the role of libraries in providing access to agricultural data sets and software tools for AI applications. The study found that while libraries do have a role to play in providing access to these resources, there are significant challenges in terms of data management and curation, as well as a lack of technical expertise among library staff. The study suggests that collaboration with AI experts and the development of tailored resources can help overcome these challenges. Another study by Jiao et al. (2020) investigated the use of personalized services, such as consultations and training sessions, to support the adoption and implementation of AI technologies in agriculture. The study found that such services can be effective in addressing the technical knowledge gap among farmers and agricultural researchers. However, the study also highlights the need for ongoing support and training to ensure the continued effectiveness of these services.

A study by Yang and Lu (2020) examined the challenges faced by libraries in providing access to AI technologies and data sets in rural areas of China. The study found that inadequate infrastructure, poor internet connectivity, and a lack of technical expertise were significant barriers to the adoption of AI technologies in agriculture in rural areas. The study suggests that libraries can play a role in addressing these challenges by providing access to technology and expertise and by collaborating with local communities to develop tailored solutions. In a study conducted by Muneer and Khurshid (2020) in Pakistan. The study explored the role of libraries in supporting the adoption and use of AI in agriculture, focusing on the availability and accessibility of relevant resources, such

as books, journals, databases, and software tools. The study found that while there were some resources available in libraries, they were often outdated and insufficient to meet the information needs of agricultural researchers and practitioners working with AI technologies.

A study by Alshehri et al. (2021) investigated the role of academic libraries in supporting precision agriculture in Saudi Arabia. The study examined the availability and accessibility of resources such as books, journals, and databases related to precision agriculture. The study found that while there were some resources available, they were not sufficient to meet the information needs of agricultural researchers and practitioners working with precision agriculture technologies. The study recommended that libraries should develop new resources and services tailored to the specific needs of agricultural researchers and practitioners working with precision agriculture technologies.

Literature Gap

This literature discusses the use of artificial intelligence (AI) in agriculture and its potential to revolutionize the industry. No doubt, AI has been used to increase crop production, improve food security, reduce the workload on farmers, and make predictions related to yield and weather. However, the successful adoption of AI technologies in agriculture is hindered by several challenges, such as lack of access to technology, insufficient technical knowledge, high costs of acquiring and maintaining AI technology, inadequate infrastructure, poor internet connectivity, and inadequate power supply. There is also a literature gap on the role of libraries in supporting the adoption and implementation of AI technologies in agriculture, which requires collaboration with AI experts and the development of tailored resources to overcome the challenges.

Methodology

The methodology employed in this study aimed to investigate the impact of artificial intelligence (AI) on agriculture to address challenges related to food security and efficiency in the Fourth Industrial Revolution, as well as the role of libraries in this transformation. The research employed a qualitative approach, specifically in-depth interviews with 30 experts in the field of agriculture and AI from the six agricultural research institutes in the six geo-political zones of Nigeria. These research institutes include; Nigeria Stored Product Research Institutes, Ilorin, North-Central, National Horticultural Research Institute, Ibadan, South-West, National Root Crop Research Institute, Abia, South-East, Lake Chad research institutes, Borno, North East, and National Animal production research institute, Zaria, North-West, Nigeria. The participants included one librarian from the institute library and four agricultural researchers who had knowledge and experience in the intersection of agriculture and AI. Using a snowball sampling method, One librarian from each institute was purposively selected to identify the agricultural researchers who had

experience and interest in leveraging AI for the transformation of agricultural activities. However, data collection was possible through interviews using a focused group discussion (FGD), which was conducted via the Zoom platform. The interviews were open-ended to elicit detailed responses from the participants. The sample size was determined by data saturation, which was the point where no new insights or information were obtained from the interviews. The data collected were analyzed using a thematic approach. The data were transcribed and coded according to themes and categories that emerged from the interview session. The research adhered to ethical considerations to ensure the confidentiality, anonymity, and voluntary participation of the participants.

The participants were informed about the study's purpose and their right to withdraw at any time without any consequences. Informed consent was obtained from all participants before the interviews. The study's limitations included the availability of experts in the field of agriculture and AI who were willing to participate in the study and the small sample size, which may not generalize the findings to the entire population of agriculture and AI.

Table: Code Assigned to Participants

NO	Nigeria Geopolitical Zone	CodeAssignedtoParticipant
1.	South-south	P1,P2,P3,P4,P5,
2.	South-west	P6,P7,P8,P9,P10,
3.	South-east	P11,P12,P13,P14,P15,
4.	North-central	P16,P17,P18,P19,P20,
5.	North-east	P21,P22,P23,P24,P25,
6.	North-west	P26,P27,P28,P29,P30,

Results and Discussion

Research Objective: To investigate the potential of AI in reducing resource waste and improving crop yields in agriculture in Nigeria. No doubt, agriculture in Nigeria faces several challenges such as limited resources, high cost of inputs, climate change, and low productivity. This study aims to explore the impact of AI on the agricultural sector in Nigeria, with a focus on how AI can reduce resource waste and improve crop yields. Participants were asked to provide their perceptions of the use of AI in agriculture and its potential to address these challenges. Responses from the participants were thematically analyzed to identify the key themes and patterns that emerged from their responses: P1 believes that AI has the potential to greatly improve efficiency in agriculture. For example, he noted, "Sensors and machine learning algorithms can be used to analyze data to make more informed decisions about planting, irrigation, and fertilization." This sentiment is shared by P3 and P5,

who believe that AI can help optimize crop yields by analyzing data about soil quality, weather patterns, and plant health. By using AI in these ways, farmers can save time and money while also reducing waste.

P4 expresses concern about job losses in agriculture and increased inequality as a potential challenge associated with the use of AI in agriculture. This concern is echoed by P2, P6, and P7, who note that although AI can create new job opportunities in areas like data analysis and programming, training and education programs are needed to help people develop these skills.P10 and 13 raise concern about data privacy and how farmers should share and manage data about their crops and land. P8 and P9 agree that data privacy is a critical concern, and suggest that regulations and policies can help protect farmers' rights.P11, P16, P20 and P21 highlight the ethical implications of using AI in agriculture, including decisions about which crops to plant and when, which could be influenced by biased data. P9, P12 and 28 note the importance of being aware of potential biases in data and algorithms, and involving farmers and other stakeholders in decision-making processes.P16, P26 and 27 emphasize the importance of making AI accessible to all farmers, not just those with the resources to invest in expensive technology. P30 agrees and notes that developing affordable, user-friendly technology that can be adapted to different farming contexts is essential.

P17 cites the example of precision agriculture, where sensors and GPS are used to collect data on soil and crop conditions, which is then used to make decisions about planting, irrigation, and fertilization. This leads to reduced inputs and increased efficiency, while also improving yields. P21 mentions the use of AI in plant breeding, where machine learning algorithms can help identify genes and traits that are associated with desired characteristics, such as drought tolerance or disease resistance. This can speed up the breeding process and produce crops that are better adapted to changing environmental conditions. P8, P15, P17, P28 and P26 discuss the use of drones equipped with cameras and sensors to monitor crops, which can help detect disease, pests, or nutrient deficiencies early on, allowing farmers to take action before the problem spreads. P1 and P9 point out the potential for AI to help with labour-intensive tasks like fruit and vegetable harvesting, which can be difficult to automate using traditional machinery. Robots equipped with sensors and computer vision algorithms can be trained to recognize and pick ripe fruits and vegetables, reducing the need for manual labour. P6, P8, P12, P14, P17, P24, and P26 highlight the use of AI in weather forecasting, where data from sensors and satellites can be analyzed using machine learning algorithms to generate more accurate predictions of weather patterns, allowing farmers to make more informed decisions about planting and harvest timing. P19 and 23 mention the use of blockchain technology in agriculture, which can help farmers track the origin and quality of their produce, while also ensuring transparency and traceability in the supply chain.

P17 predicts that AI will continue to play an increasingly important role in agriculture, with the

potential to transform the industry by making it more sustainable, efficient, and resilient to climate change.P6 suggests that AI has the potential to help address global food security challenges by increasing yields and reducing waste. P2, P16, P23, P27 and P30 believe that AI can help farmers adapt to changing climate conditions, by providing real-time information about weather patterns and soil moisture levels and suggesting appropriate crop management strategies. P11 and P17 highlight the potential for AI to help connect farmers with new markets and consumers, by providing data-driven insights into consumer preferences and market trends. P27 and P30 point out the potential for AI to support small-scale farmers in developing countries, who may lack access to the resources and infrastructure needed to adopt advanced farming techniques. AI-powered tools can help these farmers improve crop yields, reduce inputs, and access new markets.

P2 and P6 believe that although AI has great potential to help address challenges in agriculture, it needs to be approached with caution and consideration of broader implications for society. P9 agrees, emphasizing the need to balance the benefits of AI with the potential risks and ensure that it is used in a way that promotes sustainability, equity, and social responsibility.

The participants generally express positive perceptions of AI in agriculture, highlighting its potential to improve efficiency, increase yields, and promote sustainability. They also discuss the challenges associated with AI in agriculture, including potential job losses, data privacy concerns, and ethical implications. Examples of AI in agriculture are cited, including precision agriculture, plant breeding, drones, and weather forecasting. Participants predict that AI will continue to play an important role in agriculture, helping to address global food security challenges and supporting small-scale farmers. However, they emphasize the need to approach AI with caution, ensuring that it is used in a way that promotes sustainability, equity, and social responsibility.

Research Objective 2: To examine the current status of libraries in supporting the adoption and implementation of AI technologies in agriculture: The role of libraries in providing information resources and services to support the agricultural sector is critical. This objective aims to investigate the role of libraries in supporting the adoption and implementation of AI technologies in agriculture. Participants were asked to provide their perspectives on the role of libraries in providing access to information resources and services that can support the integration of AI technologies into agriculture. Responses from the participants were thematically analyzed to identify the key themes and patterns that emerged from their responses: P2, P4, P8, P11, P13, P15, P18, P20, P22, P25, and P29 discuss the need for greater awareness and understanding of AI technologies among librarians in the agricultural sector. P2 notes that many librarians lack knowledge about the potential applications of AI in agriculture, while P8 suggests that librarians need to be trained to understand and teach users how AI can be used to improve crop yields and reduce waste. P13 and P20

emphasize the importance of keeping up with developments in AI and related fields, while P25 and P29 suggest that librarians should be proactive in seeking out information about new AI technologies and applications to support agricultural activities.

P1, P3, P5, P7, P9, P10, P12, P14, P16, P17, P19, P21, P23, P24, P26, P27, P28, and P30 discuss the role that libraries can play in supporting the adoption and implementation of AI technologies in agriculture. P1 notes that libraries can serve as a resource for farmers and researchers looking to learn more about AI applications in agriculture, while P9 suggests that libraries can provide access to data sets and other resources needed to develop AI technologies. P14 and P19 discuss the potential for libraries to serve as a hub for collaboration and knowledge-sharing among stakeholders in the agricultural sector. P21 notes that libraries can support research into AI applications in plant breeding and genetics, while P23 suggests that libraries can help connect farmers with AI experts and technology providers.

P6, P10, P11, P12, P15, P18, P22, P24, P25, and P29 discuss the challenges and barriers to the adoption and implementation of AI technologies in agriculture. P6 notes that many farmers lack the resources and technical expertise needed to adopt AI technologies in farming, while P10 and P29 suggest that concerns around data privacy and ownership may hinder AI adoption. P11 and P15 raise concerns about the potential for bias in AI algorithms, while P18 notes that regulatory frameworks and ethical guidelines may be needed to ensure that AI is used responsibly and sustainably. P22 and P25 discuss the need for investment in infrastructure and training to support the adoption of AI technologies in agriculture.

P1, P3, P5, P7, P9, P12, P14, P16, P17, P19, P21, P23, P24, P26, P27, P28, and P30 provide examples of AI applications in agriculture. P1, P3, P5, and P16 discuss the use of AI to optimize crop yields by analyzing data on soil quality, weather patterns, and plant health. P7 and P17 mention the use of precision agriculture technologies like sensors and GPS to collect data on crop and soil conditions. P9 and P24 discuss the use of AI in crop modelling and simulation, while P14 and P19 mention the use of AI to support sustainable agriculture practices like crop rotation and intercropping. P21 notes that AI can be used to identify genes and traits associated with desirable plant characteristics, while P26 and P27 mention the use of drones and satellite imagery to monitor crop health and yields.

P8 and P12 highlight the challenge of funding and resource allocation, noting that libraries may not have the financial resources to invest in the necessary technology or personnel to support AI adoption in agriculture. P19 emphasizes the need for libraries to develop partnerships and collaborations with other organizations and stakeholders in the agricultural industry to overcome these challenges.P13 and P22 note the importance of ensuring that libraries have the necessary expertise and training to support AI adoption in agriculture. This may require investing in staff development and training programs to ensure that librarians have the knowledge and skills needed to

provide effective support information services.P20 raises concerns about data privacy and security, emphasizing the need for libraries to ensure that data collected and analyzed through AI technologies in agriculture is properly protected and managed. P28 agrees, noting that libraries should play a role in advocating for data privacy and security regulations and policies.P15 and P26 highlight the need for libraries to address issues of accessibility and equity in supporting AI adoption in agriculture. This may require developing user-friendly tools and interfaces that can be easily accessed and used by farmers with limited technological literacy, as well as ensuring that the benefits of AI are accessible to farmers of all sizes and scales.

P4 and P23 suggest that libraries can play a role in providing training and education programs to farmers and other stakeholders in the agricultural industry to help them develop the skills and knowledge needed to effectively adopt and use AI technologies. P14 and P17 suggest that libraries can act as knowledge hubs, providing access to relevant literature and research on AI in agriculture and serving as a source of expertise and guidance for farmers and other stakeholders.P5 and P27 emphasize the importance of developing partnerships and collaborations between libraries and other organizations and stakeholders in the agricultural industry to leverage resources and expertise in supporting AI adoption in agriculture. P11 suggests that libraries can also play a role in facilitating communication and collaboration between different stakeholders, helping to bridge the gap between technical experts and farmers.P9 and P25 highlight the importance of addressing issues of ethics and social responsibility in supporting AI adoption in agriculture. Libraries can play a role in promoting the responsible and ethical use of AI technologies and advocating for policies and regulations that ensure the fair and equitable distribution of benefits from AI adoption in agriculture.

P3, P10, and P24 believe that libraries will play an increasingly important role in supporting AI adoption in agriculture as technology becomes more prevalent in the industry. P18 and P21 suggest that libraries may also play a role in facilitating innovation and development of new AI technologies in agriculture, by providing access to relevant literature, data, and expertise.P16 and P29 highlight the potential for libraries to play a role in promoting sustainable and environmentally responsible AI adoption in agriculture, by providing access to relevant research and best practices. P30 suggests that libraries can also play a role in helping farmers adapt to changing climate conditions, by providing access to information and expertise on the use of AI technologies for climate adaptation and resilience.

The findings presented discuss the perceptions of librarians on AI adoption in agriculture. The study identifies six themes based on the analysis of 30 interviews: (1) Awareness and Understanding of AI in Agriculture, (2) Role of Libraries in Supporting AI Adoption in Agriculture, (3) Challenges and Barriers to AI Adoption in Agriculture, (4) Examples of AI Applications in Agriculture, (5) Challenges Faced by Libraries in Supporting AI Adoption in Agriculture,

and (6) Strategies for Libraries to Support AI Adoption in Agriculture. The librarians acknowledged that AI has potential applications in agriculture, but many of them lack knowledge about AI technologies. Libraries can support the adoption and implementation of AI in agriculture by providing access to data sets, acting as a hub for collaboration and knowledge-sharing, and connecting farmers with AI experts and technology providers. However, challenges such as a lack of resources and technical expertise, concerns about data privacy and ownership, potential bias in AI algorithms, and regulatory frameworks and ethical guidelines can hinder AI adoption.

Research Objective 3: To assess the effectiveness of existing library services and resources in meeting the information needs of agricultural researchers and practitioners working with AI technologies: The availability and effectiveness of library services and resources are critical factors in supporting agricultural researchers and practitioners working with AI technologies. This objective aims to evaluate the effectiveness of existing library services and resources in meeting the information needs of agricultural researchers and practitioners working with AI technologies. Participants were asked to provide their perspectives on the effectiveness of existing library services and resources in supporting the integration of AI technologies into agriculture.

Responses from the participants were thematically analyzed to identify the key themes and patterns that emerge from their response:The participants' feedback on their satisfaction with the existing library services was positive and indicated that their institute libraries are meeting their needs in different ways. P5 expressed their high level of satisfaction with the range of resources available at their library. They find the resources easily accessible and useful for their research needs. Similarly, P11 mentioned that the library services at their institute have been effective in meeting their information needs on AI technologies in agriculture, with access to a variety of databases and e-books. P20 was also impressed with their institute's library services, highlighting the availability of a great collection of books, journals, and other resources that have been useful for their research. These responses indicate that the existing library services are meeting the needs of agricultural researchers and practitioners working with AI technologies.

As the participants shared their experiences, highlighting the availability of resources in the library. P2 explained that some resources related to AI technologies in agriculture were not available in their institute library, making it challenging to find the information needed. Similarly, P8 reported that while their institute's library had a good collection of resources on agriculture, some of the resources related to AI technologies were outdated. They suggested having access to more current resources. On the other hand, P15 stated that they were able to find most of the resources they needed in the library, but some resources related to specific subtopics within AI technologies in agriculture were not available. They recommended expanding the library's collection to include more resources on these topics.

As the study progressed, another important theme emerged, which was the accessibility of resources in the library. Participants expressed their experiences with the availability and ease of accessing the resources related to AI technologies in agriculture. P4 shared that some of the resources were not easily accessible due to login requirements that were not available to all users. P9 stated that while the institute library had a good collection of resources, finding the needed information could be challenging because the search tools not being user-friendly. Similarly, P23 expressed their concern about the difficulty in accessing resources remotely and suggested that the library should improve its remote access options.

Few participants noted the adequacy of information provided by the library to meet the specific needs of agricultural researchers and practitioners working with AI technologies is limited. P7 mentioned that some of the information available in the library was not relevant to their research on AI technologies in agriculture, highlighting the need for more targeted resources. P12 echoed this sentiment, mentioning that while some resources were available, they were too general and did not provide enough detail. They hoped the library could provide more in-depth resources. P27 also pointed out that some of the resources in the library were biased towards certain perspectives on AI technologies in agriculture, highlighting the need for more balanced resources. The participants agreed that the library needed to provide up-to-date, comprehensive, and unbiased information to aid their research.

Several participants highlighted the challenges and limitations they face while accessing information resources from existing library services. P16 pointed out that the resources available in the library may not always be up to date with the latest developments in AI technology. P21 mentioned that the library's database can be difficult to navigate, making it challenging to locate and access the relevant information. P25 raised concerns about the accessibility of library resources for researchers working in remote areas.

Participants provided various suggestions for improving library services for agricultural researchers working with AI technologies. P3 suggested that libraries could collaborate with AI experts to develop resources tailored to the needs of agricultural researchers. P12 recommended the implementation of personalized services to provide researchers with access to relevant and up-to-date information. P20 suggested that libraries could provide training and workshops to help researchers develop skills in using AI technologies to analyze data.

The findings from the study indicate that while the existing library services are meeting the needs of agricultural researchers and practitioners to a certain extent, there is still room for improvement. Participants highlighted the need for more up-to-date, comprehensive, and unbiased information resources that are easily accessible and targeted towards specific subtopics within AI technologies in agriculture. Participants also expressed concerns about the accessibility of resources, search tools, and databases. The study also revealed several

suggestions for improving library services for agricultural researchers working with AI technologies. These suggestions include collaboration with AI experts to develop tailored resources, personalized services, training and workshops on AI technology, and improving remote access options. These findings are crucial for library professionals to consider as they work towards improving their services to meet the needs of agricultural researchers and practitioners working with AI technologies.

Discussion of Findings

The findings discussed suggest that there is generally a positive perception of AI in agriculture, with potential benefits such as increased efficiency, yield, and sustainability. This is consistent with previous studies, which have shown that AI has the potential to revolutionize agriculture by providing real-time monitoring and analysis of agricultural processes, allowing for more precise and efficient use of resources, and enabling more sustainable and environmentally friendly farming practices (García-Santillán et al., 2020). However, the study also identifies several challenges and concerns associated with AI adoption in agriculture, such as job loss, data privacy, and ethical implications. These concerns are echoed in other studies, which have also identified issues such as the potential for bias in AI algorithms and the need for regulatory frameworks and ethical guidelines to ensure that AI is used in a socially responsible and sustainable manner (Chen et al., 2020; Gómez-Sanchis et al., 2021). The study also highlights the important role that libraries can play in supporting the adoption and implementation of AI in agriculture. This is consistent with previous studies, which have shown that libraries can act as a hub for collaboration and knowledge-sharing, providing access to data sets and resources that are critical for AI research and development (Liu et al., 2020). However, the study also identifies several challenges that libraries face in supporting AI adoption in agriculture, such as a lack of resources and technical expertise, concerns about data privacy and ownership, and difficulties in accessing up-to-date and comprehensive information resources. To address these challenges, the study findings suggest several strategies for libraries to improve their services for agricultural researchers and practitioners working with AI technologies. These strategies include collaboration with AI experts, developing tailored resources, providing personalized services, and offering training and workshops on AI technology. These suggestions are consistent with previous studies, which have emphasized the importance of libraries in supporting AI research and development and have suggested strategies such as providing training and support to researchers, developing data management plans, and establishing partnerships with industry and government stakeholders (Barranco et al., 2020; Kiefer and Waller, 2021).

Conclusion

In conclusion, the findings discussed in the study underscore the potential of AI to transform agriculture and improve food security. Thus, this study provides insights into the perceptions of librarians and agricultural scientists on AI adoption in agriculture, highlighting

the potential benefits and challenges associated with this technology. The study findings suggest that AI has the potential to bring significant benefits to agriculture, including increased efficiency, yield, and sustainability. However, there are also concerns and challenges associated with AI adoption, such as job loss, data privacy, and ethical implications, which need to be addressed to ensure that AI is used in a socially responsible and sustainable manner. The study highlights the important role that libraries can play in supporting AI adoption in agriculture by providing access to critical data sets and resources, acting as a hub for collaboration and knowledge-sharing, and connecting farmers with AI experts and technology providers. However, to improve their services for agricultural researchers and practitioners working with AI technologies, libraries need to address challenges such as a lack of resources and technical expertise, concerns about data privacy and ownership, and difficulties in accessing up-to-date and comprehensive information resources. By implementing strategies such as collaborating with AI experts, developing tailored resources, providing personalized services, and offering training and workshops on AI technology, libraries can play a vital role in supporting AI adoption in agriculture and helping to address the global food security challenges.

Implications for Policymakers

Based on the study findings, policymakers can take several actions to promote the responsible and sustainable adoption of AI in agriculture.

1. First, policymakers should establish regulatory frameworks and ethical guidelines to address the potential risks associated with AI adoption, such as data privacy and bias in AI algorithms. This could include establishing data ownership and sharing rules, developing standards for algorithmic transparency and accountability, and promoting the development of unbiased and explainable AI models.
2. Second, policymakers should invest in the development of AI infrastructure and resources to support the adoption of AI in agriculture. This could include funding for research and development of AI technologies tailored to agriculture, supporting the development of data-sharing platforms and libraries, and promoting the adoption of open data standards.
3. Finally, policymakers should promote collaboration and knowledge-sharing among different stakeholders, such as farmers, researchers, libraries, and AI experts. This could include establishing partnerships between academic and research institutions, industry stakeholders, and government agencies to promote the development and adoption of AI technologies in agriculture.

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