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Smart libraries for smart farming: The role of AI in agricultural information services: A review

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Abstract

The integration of Artificial Intelligence (AI) in agricultural information services is revolutionizing the farming sector. Smart libraries, equipped with AI-driven technologies, provide stake holders with real-time data, predictive analytics and decision-making support systems. Artificial Intelligence is revolutionizing library and information services (LIS) across various domains, including agriculture. It explores AI-driven cataloging, precision information services and data analytics for agricultural studies and also discusses challenges such as data privacy, ethical considerations, and digital literacy, concluding with future directions for AI-driven agricultural library services. AI has found numerous applications in libraries ranging from book filing to book delivery. The application of Artificial Intelligence is a developing technology in the field of librarianship. AI to solve teaching and research problems related to the application of AI in libraries. The integration of AI in agricultural library services enhances the accessibility and management of agricultural data, making research more efficient and impactful.

Keywords: Artificial intelligence, knowledge, cataloguing, machine learning

Introduction

Agriculture is a crucial sector that sustains global food security. Traditional farming practices often rely on manual expertise and historical knowledge, which may not be sufficient to tackle modern agricultural challenges such as climate change, pest infestations, and resource optimization (Jesubukade *et al*., 2021) [1]. AI has emerged as a transformative force in agricultural information services, enabling smart libraries that provide accurate, timely, and actionable insights to farmers, researchers, and policymakers. Artificial intelligence (AI) is an aspect of computational science that is concerned with making machines provide answers to complicated and difficult issues in a way that humans do. Human cognitive characteristics are appropriated, modelled, and integrated as algorithms in a manner that computers understand and can process to give an output or result. In its logical approach, Artificial Intelligence is a neural network, which is a network of artificial neurons or nodes that mimics the human biological processes of neurons. It was developed in a system to imitate the structural organisation of the neural activities of humans. The neural network collectively generates informed decisions as they pass from one to the other. Artificial intelligence started as a field in the 1950s and its application to libraries started as early as the 1990s. However its wide use among the different information seeking groups started recently with the acquaint of internet facilities which are AI assisted programmes in smart phones and IoT (Omame and Alex-Nmecha, 2020) [2].

Intelligent Information Retrieval and Semantic Search

AI-driven search engines enhance information retrieval in agricultural libraries by using Natural Language Processing (NLP) and semantic search capabilities. Traditional keyword-based search engines often fail to provide precise results due to ambiguity in agricultural terminologies. AI-powered semantic search engines analyze contextual meanings to deliver more relevant results.

For example, AI-powered platforms like AGRIS (International System for Agricultural Science and Technology) leverage NLP to improve search efficiency for agricultural researchers. AI enhances query expansion, enabling users to retrieve information beyond exact keyword matches, thus improving accessibility to agricultural knowledge.

Automated Cataloging and Classification

AI-powered tools streamline the classification and organization of agricultural literature. Machine learning algorithms assist in automated metadata generation and taxonomy classification, improving the accessibility of agricultural research papers, datasets, and extension materials. AI can analyze text patterns and automatically assign subject classifications, ensuring consistency and accuracy in cataloguing.

For instance, AI-driven tools like BERT (Bidirectional Encoder Representations from Transformers) and deep learning-based classifiers improve the accuracy of document categorization in agricultural repositories. These

technologies help to reduce manual efforts and minimize errors in indexing and classification (Lancaster and Al-shaleel, 2008) [3].

Chatbots and Virtual Assistants for Agricultural Queries AI-powered chatbots assist researchers, extension workers and farmers by providing real-time access to agricultural information. These virtual assistants can answer questions on best farming practices, pest control, and weather patterns, thus improving knowledge dissemination. Chatbots enhance user interaction in digital libraries, reducing response times and improving accessibility for farmers who may not be well-versed in using traditional search systems.

AI in Digital Libraries and Agricultural Archives- AI facilitate the digitization and preservation of historical agricultural documents. Optical Character Recognition (OCR) and machine learning enhance text recognition and indexing, making historical and contemporary agricultural research more accessible. Libraries and archives worldwide are using AI to transcribe, annotate and organize historical agricultural records, ensuring their longevity and usability (Jesubukade *et al*., 2021) [1].

The Indian Council of Agricultural Research (ICAR) and the Food and Agriculture Organization (FAO) have implemented AI-driven digitization projects to preserve agricultural manuscripts, reports, and policy documents. These initiatives improve data accessibility and contribute to sustainable farming practices.

AI for Decision-Making and Agricultural Knowledge Management- AI supports data-driven decision-making in agricultural research by analyzing large datasets on climate patterns, crop diseases, and soil fertility. AI-based predictive analytics help libraries curate relevant resources and provide tailored recommendations to researchers and policymakers.

For instance, AI can analyze past research trends in agricultural science and suggest emerging areas for further investigation. AI-driven bibliometrics analysis tools can identify influential papers, key contributors, and gaps in research, assisting policymakers in making informed decisions about funding and policy development (Cox *et al*., 2019) [5].

Applications of AI in Agricultural Library and Information Services

Smart libraries leverage AI to enhance the accessibility and dissemination of agricultural knowledge. The key components of AI-driven agricultural information services include (Al-maliki, 2003) [4]:

- **Big Data Analytics**: AI processes vast amounts of agricultural data to derive meaningful patterns and insights.
- **Machine Learning (ML) and Predictive Modeling**: ML algorithms forecast crop yields, pest outbreaks, and soil health conditions.
- **Internet of Things (IoT) and Sensor Networks**: IoT devices collect real-time data from fields, which AI systems analyze to provide actionable recommendations.
- **Natural Language Processing (NLP)**: NLP enables intelligent search and retrieval systems in smart libraries, allowing users to access relevant agricultural literature efficiently.
- **Expert Systems and Chatbots**: AI-driven chatbots assist farmers by answering queries related to weather conditions, pest control, and best farming practices.

Applications of AI in Smart Farming

The application of AI in agriculture spans multiple domains, including:

- **Precision Agriculture:** AI optimizes resource use by analyzing soil health, water levels, and climatic conditions to provide precise recommendations.
- **Automated Disease and Pest Detection:** AI models detect early signs of crop diseases and pest infestations, enabling timely interventions.
- **Supply Chain Optimization:** AI-powered systems streamline logistics, inventory management, and market price predictions.
- **Weather Forecasting and Disaster Management:** AI enhances meteorological predictions, helping farmers prepare for adverse weather conditions.
- **Livestock Monitoring:** AI-driven smart sensors track animal health and behavior, improving livestock management and productivity.

Challenges in Implementing AI in Agricultural Libraries and Ethical Considerations Despite its benefits, AI in agricultural LIS poses challenges:

- **Data Privacy and Security:** Managing sensitive agricultural research data requires robust security measures. AI systems processing agricultural datasets must ensure compliance with data protection regulations, such as GDPR and other country-specific laws.
- **Bias in AI Algorithms:** AI-driven recommendations may reflect biases present in training data, affecting decision-making in agriculture. If AI tools are trained on incomplete or biased datasets, they may provide skewed recommendations, negatively impacting farming practices.
- **Digital Literacy Requirements:** Agricultural researchers and extension workers need training to effectively use AI-based tools. Many farmers, particularly in developing regions, may lack the digital skills necessary to interact with AI-driven LIS effectively.
- **Ethical Concerns:** The automation of agricultural library services should ensure human oversight and accountability. Over-reliance on AI may lead to the loss of human expertise in curating and verifying agricultural information.

Future Prospects of AI in Agricultural Information Services.

The future of AI-driven smart libraries in agriculture looks promising with ongoing advancements in AI technology. Key areas of future development include:

- **Integration of Blockchain Technology**: Blockchain can enhance data security, transparency, and traceability in agricultural information services.

- **AI-Powered Decision Support Systems**: Advanced AI models will further improve decision-making capabilities for farmers and policymakers.
- **Expansion of Cloud-Based Agricultural Libraries**: Cloud computing will facilitate the storage and sharing of vast agricultural datasets.
- **Enhanced Collaboration Between AI and Traditional Knowledge Systems**: Combining AI insights with indigenous farming knowledge can lead to more effective agricultural practices.

Conclusion

AI-driven smart libraries are transforming agricultural information services by providing stake holder with accurate, timely, and actionable insights. These technologies enhance productivity, sustainability, and resource efficiency in the farming sector. However, challenges such as infrastructure costs, digital literacy, and policy constraints must be addressed to maximize AI's potential. Future developments in AI, blockchain, and cloud computing hold the promise of further revolutionizing agricultural information services, ensuring food security and sustainable farming practices worldwide. In future efforts should focus on ensuring inclusivity, ethical AI deployment, and enhanced digital literacy to maximize the benefits of AI in agricultural libraries. With responsible adoption, AI can significantly improve agricultural research dissemination and decision-making, benefiting farmers, researchers, and policymakers alike.

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