World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(RESEARCH ARTICLE)

Check for updates

Exploring AI-driven solutions for Libyan agriculture: Current applications and strategic pathways

Ali Bakeer *

Faculty of Information Technology, University of Misurata, Misurata, Libya.

World Journal of Advanced Research and Reviews, 2024, 24(01), 1344–1349

Publication history: Received on 06 September 2024; revised on 14 October 2024; accepted on 16 October 2024

Article DOI: https://doi.org/10.30574/wjarr.2024.24.1.3144

Abstract

The study aims to explore the deployment of AI in the agriculture activities in Libya. It adopts case study method that employed an online questionnaire followed by an interview with an expert in the field of agriculture sector for gathering more insights from the participants engaged in agriculture business activities in Libya. The Questionnaire presents a set of questions that aims to cover various aspects related to the AI deployment and use in the agriculture business sector development. The results from the primary collected data support the study to assess the current deployment of AI technologies, identify potential areas of improvement, and explore the potential expectation regarding AI future role in Libyan agriculture sector. Also, provide significant understanding into the existing use and adoption of AI applications and Tools in the sector, which indicates both the progress made so far and the area that more efforts are still need to be done for leveraging the potential of AI technologies for sustainable and efficient practices in the agriculture business activities. A number of barriers that could be responsible on hindering the deployment of AI technologies also was illustrated, such as infrastructure, data accessibility, and capacity building which will be a vital in understanding the full potential of AI in Libyan Agriculture, and collaboration between investors and policy makers are important to ensure the success of AI deployment for agriculture practices in Libya. The study contributes to support policy makers and stakeholders interested in leveraging AI to enhance agriculture practices and encourage sustainable agriculture business activities in Libyan Context.

Keywords: Artificial Intelligence; Agriculture; Smart Farming; Data Analytics; Automation; Sustainability.

1. Introduction

According to Balafoutis et al., (2017), the use of a Smart Technologies and agriculture is dependable with the word wide movement towards precision and smart farming. Countries all around the world have seen the advantages of using AI applications and agriculture sector, including higher yields, , lower cost, and better sustainability (Dayıoğlu, Turker, 2021). However, Libya's economy starts planning for extending the investment in diversity resources including agriculture sector, which supports rural development, jobs, and food security. However, there are number of barriers that Libyan agriculture need to overcome, such as infrequent water supplies and slow pace of technological development (Abuarosha, 2013; Kaarud, 2020). There are several important actions that need to be done and it is considered as an important for using technology to address this barriers and support agriculture developments in Libya, which has been grown in the recent years (Ammari and Roosli, 2024). The study founded that Libya can establish a process of development activities for future enhancements in the agricultural sector and progress by integrating AI-based technology plan into its different agriculture business. However, Libya can develop a plan for future development and extend the agriculture activities by integrating AI technologies into its daily agriculture environment. Thus, Libya's agriculture sector is distinguished by conventional farming technique, restricted access to cutting-edge technology, and a dependence on several procedures. These issues are hindering the sector's capacity building development that are needed for the raising of advanced technologies applications in the sector.

* Corresponding author: Ali Bakeer

In similar study, Tapo et al., (2020) conducted a survey that aims to emphasizes the important of AI integration to improve the Human resources and related tasks, and advices use of smart technology to develop agriculture in future. The study aims to provide an emphasis on the Libyan context, pinpoint and examine the critical success elements that support the deployment and use of AI technologies in the agriculture sector. Also, elaborating facts on a Libyan agricultural business development and utilizing the potential of AI driven solutions in agricultural practices that requires understanding of these factors. To maintain this objective, the following research question serves as the study's compass:

What are the Critical Success Factors of AI Technology Deployment in agriculture sector in Libya?

The research questions aims to support the investigation and moderate the exploring of the fact that impacting the deployment of AI Technologies in agriculture sector also, providing variable insights to inform strategies and initiatives with required actions that are needed to enhance AI integration in the Libyan agriculture activities.

1.1. An overview of AI applications in the agriculture sector

Wildan (2023) argued the impact on leveraging of the AI basic Technologies which is indicated that Libyan stakeholders can optimize crop monitoring resource allocation and decision-making support process. The AI tools can also help an early detection of a crop disease, improve irrigation practice, and enhance yield predictions, then maximizing efficiency. AI based Technology has the capability to deliver real time insights and recommendations. For instances, empowering stockholders to make informed decisions on crop farming techniques, and market trends. This support potentially leading to Improvement of its profitability, Market competitiveness, and sustainable agriculture practice. The integration of AI in Libya agriculture could reflect a considerable factor that can provide a contribution to bring changes by optimizing Resources management, improving crop yield, and enhancing productivity. The results presented by the study of (Taneja et al., 2020) highlighted importance of AI to help mitigating environmental factors, such as water scarcity and climate change by enabling more technology based for farming processes and reducing a chemical use. Sensors equeped with AI technology also can suport collection of real time data which help to empower stakeholders with personalized recommendations for informed decisions-making. This technology could provide support for creative approaches to farming management, disease detection, and crop monitoring. However, Krpalkova et al. (2021) argue that AI models can help with supply chain management and market forecasting by enabling detailed crop and harvest prediction. According to their study, AI-powered data analytics and decision support systems offer insightful information for well-informed farm management decision-making. The AI also provide potential to transform farming methods, improvement output, and encourage constructive changes in agricultural systems when they are integrated into the agricultural sector (Krpalkova et al., 2021). Investigative the current level of AI adoption in Libyan agriculture, could help for highlighting successful integration cases, stress statistical data, and offering insights from relevant studies that are the objectives of this review of the literature.

1.1.1 Challenges and considerations

Tapo et al. (2021) highlight a number of issues that must be resolved for successful AI deployment processes and tools integration in agriculture sector. For instance, inadequate sensor networks and unreliable internet connectivity are cases of infrastructure limitations that make data collection and communication problematic. In addition, Singh and Kaur, (2022) argue that the complete application of AI algorithms is further disadvantaged by the lack of high-quality agricultural data, such as historical documents and meteorological data. The precision and efficacy of AI models and forecasts are hindered by these infrastructure and data limitations. Furthermore, these number of barriers could prevent AI from being widely used in Libyan agriculture. It is difficult to deploy and use AI technologies in rural areas due to a lack of infrastructure and connectivity (Singh and Kaur, 2022). The scarcity of quality agricultural data is compounded by other factors above-mentioned, which are critical for using AI techniques toward predictions and real-time insights (Xu et al., 2021). Though awareness, technical competence, and training in the field of AI are important factors, stakeholders and agricultural workers are nevertheless presented with considerable challenges. Education and support are imperative to fill in the skill gap so as to allow successful application of AI technologies. Ahmed et al., (2024) investigate AI based the chatbots and related virtual assistants' tools for its capabilities to render information on crop management practice and farming control the study elaborate that, providing training, learning, and sustainable skills developments could be indicated by adopting such kind of tools. Other challenges for small stakeholders or businesses with limited financial resources include costs such as hardware, software, and ongoing maintenance. The adoption of such technologies will depend on the availability and affordability of AI for broader utilization. AI applications can optimize resource allocation (water use, fertilizer application, and pest control) with real-time information and predictive analytics, thus reducing costs, guaranteeing a balanced and sustainable agricultural process (Javaid et al., 2023). Integration of AI technologies with traditional farming practices requires careful planning, education, and

support so as to allow acceptance by stakeholders accustomed to conventional ways of farming. Treating some tangible benefits will increase the acceptance of AI integration and its compatibility with the existing profession. The integrated AI systems will need to incorporate the conditions of climate and environmental behavior in a locale, as alterations in climate and extreme weather events may further affect the reliability of AI predictions and recommendations (Konya and Nematzadeh, 2014). The following table illustrates the expected factors of AI integration in the agriculture sector in Libya:

Table 1 An expected critical AI Integration factors in agriculture sector

No	Factor	Description
1	Infrastructure	Availability of reliable internet connectivity, sensor networks, and technological infrastructure to support AI implementation
2	Data access and quality	Availability of relevant and accurate agricultural data, including historical records, weather data, and soil information
3	Skills, knowledge and Traditional Farming	Training programs and capacity building initiatives to enhance stakeholders ' and agronomists' understanding of AI technologies and their practical applications
4	Regulatory framework and Environmental Factors	Development of policies and regulations that encourage AI adoption in agriculture while addressing concerns related to data privacy and security
5	Financial resources and Cost and Affordability	Access to funding and investment opportunities to support the development and implementation of AI solutions in the agricultural sector
6	Collaboration and partnerships	Foster collaboration between government agencies, research institutions, technology providers, and stakeholders to share knowledge, resources, and best practices
7	Climate and Environmental Factors	AI systems heavily rely on historical weather patterns and data, and changes in climate patterns, extreme weather events, or unique local environmental conditions may impact the accuracy and effectiveness of AI predictions and recommendations.
8	Policy Framework	Effective policymakers, researchers, technology providers, and relevant stakeholders is crucial to create a supportive ecosystem. Establishing policies that facilitate AI adoption, address challenges, and promote investment in AI for agriculture is important for sustained growth.

However, the synergy between the stockholders, policymakers, researchers, suppliers of technology, and others stakeholders is highly fruitful to encourage favorable ecosystems that facilitates the adoption of AI. Indian drink policies that ease integration of AI, address the challenges, and simulate Investments in AI for agriculture is significant for it is sustainable. Such challenges suggest that a holistic approach, addressing the technical, economic, social, and regulatory dimensions, should be established to overcome barriers to AI adoption in Libyan agriculture. Such challenges suggest that a holistic approach, addressing the technical, economic, social, and regulatory dimensions, should be created to overcome barriers to AI adoption in the agriculture business development domain in Libya.

2. Modelling and framework

Based on the literature, this study develops a prototype as a proof-of-concept solution for the integration of AI in Libyan agriculture. This model is intended to drive positive changes by highlighting specific areas of AI application. This involves AI-enabled applications, development processes of data analytics, and configuration of sensor technologies or remote sensing data on data collection. The literature highlights various important factors which warrant consideration for a successful integration of AI. Those have been used to formulate a richness of recommendations and guidelines. Recommendations include infrastructure requirements, training and capacity development for key stakeholders, policy support, as well as long-term sustenance. The model given in Figure 1 shows and investigates the factors to develop an effective action plan. Some of the identified critical factors are including:

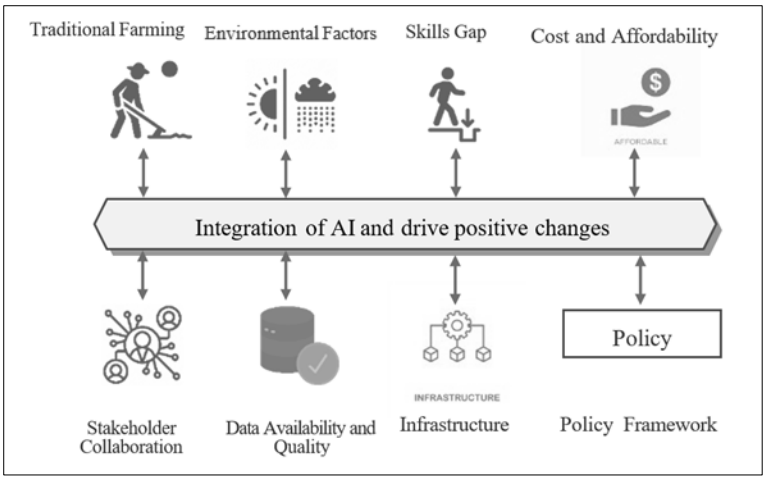

Figure 1 The model of AI integration in agricultural practices in Libya

3. Methodology

The data collection for the study conducted a development and online questionnaire directed toward this Gathering key that the items, the data illustrate the statue of AI usability in agriculture activities in Libya. This include farming practice, crop yield, Climate data, challenges being encountered. The status of the basis for the model to integrate AI Technologies. For instance, Abdelwhab, (2012) investigate stockholders' engagement with an expert in the Libyan agriculture sector, the participants included stockholders from agricultural expertise, policymakers and Technology providers. Interviews and surveys will be used to build information on their needs challenges and perceptions with respect to AI Integrations. This study did engage stakeholders' experts to ensure alignment of the proposed options with the Libyan agricultural ending realities. Nonetheless, on the basis of that collected data and input from stakeholders, a few applications of AI, suitable to manage the challenges, must be identified to foster positive changes in Libyan agriculture. This may include precision farming, detecting crop diseases, optimizing irrigation, predicting yield, and market analysis.

4. Results and Discussion

The results show the extent of adoption and perception of AI technologies in agriculture in Libya. Judging by the responses given, AI-driven solutions seem to be seen and felt diverse in their use and familiarity with respect to agriculture. For instance, advancement in remote sensing through drone or IoT devices for data collection in agriculture appears totally unknown by the respondents. This shows that awareness and, equally significant, education is needed about these technologies among stakeholders or people who engage in agriculture. It further shows the current level of usability of AI applications in analyzing data that is pertinent to soil quality, weather patterns, or crop health. This shows that there is moderate adoption of AI for data-driven decision making in agriculture, which suggests further room for implementation. However, the use of such technological techniques appears to be relatively scant in detecting patterns, predicting yields, or optimizing resource allocation. This gap may have occurred because of insufficient use of technological applications for determining the most efficient use of resources for agricultural practices to maximize productivity. With regard to the specific AI applications factor, results will show that the low utilization of AI-enabled technology-for deploying and caring for crops when planting and harvesting-ends up indicating the limited adoption of automation of agriculture in Libya. This could emanate from various reasons including issues of cost, technological barriers, and limited awareness related to the benefits derivable from automation in agricultural activities.

In a similar manner the underutilization of intelligent education systems that modify water use according to crop requirements and weather patterns suggests a possible chance to enhance agriculture water management techniques. Since they haven't integrated AI systems for this purpose, it seems that there is not much integration of AI driven systems to optimize and control Greenhouse environments. This implies that there might be space to investigate AI powered approaches to Greenhouse optimization and management. The figure 2 illustrates the visualization of the results which shows how different factors influence AI integration and agriculture are related to one another and have an impact. Infrastructure, data access and quality, Knowledge and Skills, Financial Resources, regularity framework, collaboration, climate and environmental factors, and policy framework are just a few of the important factors that each note represents.

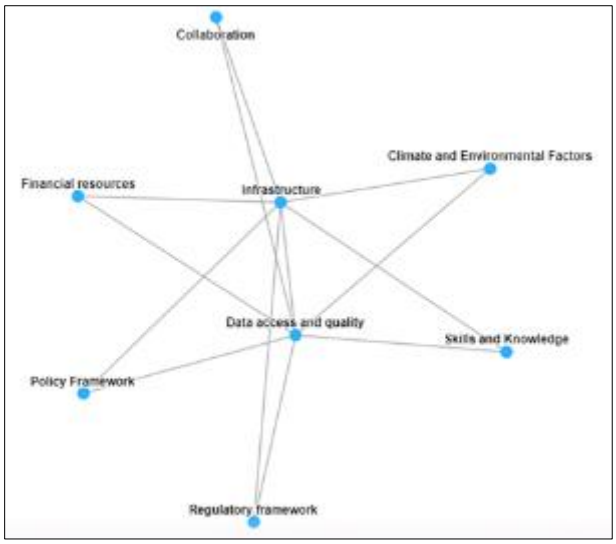

Figure 2 Interrelation of Factors in AI Integration in Agriculture

The lines connecting the nodes show how these variables relate to each other when it comes to integrating AI furthering within agriculture. For instance, type would play a vital part in enabling data access and the availability of reliable information, together with empowerment for collaboration as well regulatory compliance. Second, skill and knowledge development also depend on good data access with quality for training AI systems; which in turn shapes regulatory policies as well needed to secure finance such that the promise of circular technologies can be integrated successfully. Nonetheless, the financial resources are important to support AI technologies in agriculture from development and implementation. The infrastructure, data sharing and skills training that enables it to work; the regulations to ensure robust human rights guarantees can be attached to its operation; fostering cooperation between actors, public-private-academic where appropriate on projects of shared interest or necessity (e.g. climate adaptation); guiding wide-ranging policy into support a development agenda that incorporates but is not be holed too exclusively towards AI delivery as magic bullet, finally, the Capital conserved through strategic allocation of financial resources. For AI solutions to be sustainably innovative enough in the agricultural markets' developments are crucial. Nevertheless, by mapping such relationships stakeholders can have a clearer view modal in its entirety and make decisions that boost the chances of successfully adopting AI within agriculture. The result showed that in the infrastructure factor, reliability and availability of internet connectivity, sensor networks and related technological infrastructure for supporting AI implementation was at low levels across their ranges. It shows that the existence of required technological infrastructure could vary according to its geography which might affect AI adoption and implementation in agriculture. In contrast, results for satisfaction with the availability and quality of agricultural data (historical records, weather data and soil information) were not clearly provided.

5. Conclusion

The study results indicate a mixed level of AI deployments in Libyan agriculture, with significant room for the improvements. The limited utilization of an advanced technology presents an opportunity to explore AI-based applications, and their benefits in optimizing agricultural processes. The current minimal deployments of AI-enabled applications, such as smart irrigation and greenhouse optimization underscores the potential for technological advancement in this area. The infrastructure challenges the need for reliable connectivity and sensor Networks also considered as a significant barrier that need to be addressed overcoming. However, overcoming data related barriers and promoting knowledge to transfer are also important for the successful integration of AI. The study also indicates that collaborations, financial resources and partnership activities are essential factors to drive AI deployments effectively, the integration cases demonstrate the benefit of AI and crop monitoring estimation. To leverage AI potential for sustainable agriculture, its vital to address these challenges and foster collaborative framework. In this regard, the study provides several recommendations:

1. **Increase awareness and provide training programs:** to Enhance understanding among farmers and stockholders about the benefits of AI Technologies in agriculture, and provide training to improve their skills in utilizing these applications for optimizing agricultural processes.

2. **Improve infrastructure and data availability**: Investing in Improvement of internet connectivity, sensors network and technological infrastructure to support the implementation of AI Technologies in agriculture.
3. **Foster collaborations and financial support:** Encourage collaborations and partnership between government agencies, research institutions and Technology providers to leverage AI knowledge and resources effectively.

By addressing the above recommendation and fostering a supportive ecosystem, Libyan agriculture sector can strengthen the full potential of AI to drive sustainable agriculture practice, enhance productivity, and encourage business developments in agriculture sector.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Abdelwhab MW. The importance of agricultural infrastructure to transformation to organic farming in Libya. Sheffield Hallam University (United Kingdom); 2012.

[2] Ahmad A, Liew AX, Venturini F, Kalogeras A, Candiani A, Di Benedetto G, Ajibola S, Cartujo P, Romero P, Lykoudi A, De Grandis MM. AI can empower agriculture for global food security: challenges and prospects in developing nations. Frontiers in Artificial Intelligence. 2024 Apr 25;7:1328530.

[3] Ammari AM, Roosli R. A Review of Prefabricated Housing Evolution, Challenges, and Prospects Towards Sustainable Development in Libya. International Journal of Sustainable Development & Planning. 2024 Mar 1;19(3).

[4] Balafoutis AT, Beck B, Fountas S, Tsiropoulos Z, Vangeyte J, van der Wal T, Soto-Embodas I, Gómez-Barbero M, Pedersen SM. Smart farming technologies–description, taxonomy and economic impact. Precision agriculture: Technology and economic perspectives. 2017:21-77.

[5] Dayıoğlu MA, Turker U. Digital transformation for sustainable future-agriculture 4.0: A review. Journal of Agricultural Sciences. 2021;27(4):373-99.

[6] Kaarud Mansour Mohamed M. Management of Natural resources in function of developing agricultural production system in LIBYA. Универзитет Привредна академија у Новом Саду. 2020 Jul 6.

[7] Konya A, Nematzadeh P. Recent applications of AI to environmental disciplines: A review. Science of The Total Environment. 2024 Jan 1; 906:167705.

[8] Krpalkova L, O'Mahony N, Carvalho A, Campbell S, Corkery G, Broderick E, Walsh J. Decision-Making Strategies on Smart Dairy Farms: A Review. International Journal of Agricultural and Biosystems Engineering. 2021 Dec 2;15(11):138-45.

[9] Javaid M, Haleem A, Khan IH, Suman R. Understanding the potential applications of Artificial Intelligence in Agriculture Sector. Advanced Agrochem. 2023 Mar 1;2(1):15-30.

[10] Taneja A, Nair G, Joshi M, Sharma S, Sharma S, Jambrak AR, Roselló-Soto E, Barba FJ, Castagnini JM, Leksawasdi N, Phimolsiripol Y. Artificial intelligence: Implications for the agri-food sector. Agronomy. 2023 May 18;13(5):1397.

[11] Tapo AA, Traore A, Danioko S, Tembine H. Machine Intelligence in Africa: a survey. arXiv preprint arXiv:2402.02218. 2024 Feb 3.

[12] Wildan JF. A Review: Artificial Intelligence Related to Agricultural Equipment Integrated with the Internet of Things. Journal of Advanced Technology and Multidiscipline (JATM). 2023;2(02):47-60.

[13] Xu Y, Zhang X, Li H, Zheng H, Zhang J, Olsen MS, Varshney RK, Prasanna BM, Qian Q. Smart breeding driven by big data, artificial intelligence, and integrated genomic-enviromic prediction. Molecular Plant. 2022 Nov 7;15(11):1664-95.