International Journal of Smart Sensor and Adhoc Network

Volume 3
Issue 4 *Role of Emerging & Intelligent Technologies for the Society.*

Article 8

January 2023

How Modern Agronomy is Changing with AI and IoT post COVID-19 Pandemic: A Qualitative Study

Balavardhan Reddy
UC, Kentuky, breddy8792@ucumberlands.edu

Recommended Citation

Reddy, Balavardhan (2023) "How Modern Agronomy is Changing with AI and IoT post COVID-19 Pandemic: A Qualitative Study," *International Journal of Smart Sensor and Adhoc Network*: Vol. 3: Iss. 4, Article 8.
DOI: 10.47893/IJSSAN.2023.1231
Available at: https://www.interscience.in/ijssan/vol3/iss4/8

How Modern Agronomy is Changing with AI and IoTpostCOVID-19Pandemic: A Qualitative Study

[1] Mohammed A. Ansari, [2]Balavardhan Reddy

[1] Concordia University, Mequon, Wisconsin USA

[2]University of the Cumberlands, KY, USA

[2]breddy8792@ucumberlands.edu

Abstract-*AI and IoT are changing our day-to-day lives in every aspect, including but not limited to banking, retail, and agriculture. Dreadful obstacles confronted by agrarian and food associations involve ecological deprivation and biodiversity deficit, enduring hardship, an increasing over weightiness epidemic, nutrition uncertainty, and the use of ergonomics. However, managers and decision-makers frequently let down to admit how "awful" these matters are. Wicked difficulties want united act from the social order assemblies with profoundly apprehended, contrasting opinions and principles because their connectedness associations are stiff or incredible to detect, they cannot be expressed or resolved, deprived of detonating arguments amongst investors, and they cannot be resolved unaccompanied. All industries are directly or indirectly getting influenced by this modern technology. This research study aims to study the practical function of these technologies in the agri-food industry, which will be helpful in process models, stakeholder predictions, and correct environmental awareness to change the agri-business model. This research study findings highlight exciting issues and questions related to using AI in the agri- food industry towards the space economy to achieve a sustainable business model and better use of resources during the pandemic. Both hypothetical and administrative consequences are reviewed here.*

Keywords: Agri production management, *space economy, AI, IoT, trend analysis, Crop Quality*

I. Introduction

In the last two decades, academics, investigators, and agri-scientists have worked relentlessly to use AI and IoT to enhance the crop production. One of the primary disputes for executing artificial intelligence (AI) in agronomy involves low forge ability and inconvenience collecting information. The implementation of ML and AI tools in the agrarian segment is minimal due to the reasons like lack of awareness on its actual management. Emerging technologies like artificial intelligence (AI) and ML facilitate the agricultural science segment to accumulate and evaluate enormous volumes of information to obtain expertise, enhance farm revenue and alleviate any consequences.

During this COVID-19 pandemic, innovation is at its peak in all domains for future sustainability in this global economy [2]. The interference between human and technical resources is making good progress in meeting the world's future food needs. In this journey, AI plays a vital role in predicting the outcome of yield, weather forecasting, resource utilization, food safety and storage, and many more [1]. A growing number of companies are developing AI-enabled agri-systems to solve many problems this industry faces. The pace to use AI in practical farm usage and crop production management increased during this Covid-19 pandemic as industries face a scarcity of human laborers. As the food industry is struggling due to the COVID-19 pandemic, a profound restructuring of the entire business prototype, contemplating several monetary components, is essential to deal with the ambiguities.

II. Literature Review

There are many examples of using AI and ML in the agri-food industry since the use of AI in the food sector is becoming increasingly important due to its capacity to help reduce food waste, improve production hygiene, improve the cleaning process of machinery, and manage disease and pests [3, 4]. Automated frameworks can quickly gather and analyze a sizable amount of data on a single food item in a few seconds. Agriculture practice is vast. However, there are some key areas where AI is used, including supply chain management, soil, crop, disease, and pest control. References [5] summarize all the models that have been suggested utilizing AI approaches together with their limitations.

- For soil management: MOM (Management-Oriented Modeling) [6] for decreasing nitrate seeping, ANN (Artificial Neural Network) [8] to assess soil enzyme movement and soil formation grouping, etc., Fuzzy-logic-based SRC-DSS (Soil Risk Characterization Decision Support System) [7] for soil taxonomy,
- To create scheduling instructions for crop management, CALEX [9] PROLOG [10] to eliminate unnecessary farm equipment, ANN to identify crop nutrition issues, ANN [11] to forecast rice yield, etc., accurately.
- Disease management: Computer vision system (CVS) [12] To instantly classify frequent disorders, Databases utilizing ambiguous reasoning [12] are detailed in assessment situations. The expert system employing a rule-based disease diagnosis, ANN-GIS [13], has a 90% accuracy rate for quicker disease detection and treatment.
- For weed control: support vector machines [15], big data-based ANN-GA [14], invasive weed optimization (IWO), etc. These methods are all application-specific in the direction of a certain harvest or ecological constraint; therefore, they did not take into consideration all the variable quantities. Establishing AI structures with a variety of factors that may be employed to numerous crops is needed.

By 2050, the Food and Agriculture Organization of the United Nations projects that there will be 9 billion people on Earth[2].This rapid population growth, shrinking farmlands, and unpredictable climate change will put a lot of pressure on the world to produce a vast quantity of food to meet the food demands of the future. So, during this uncertainty, new-age tools like AI and IoT stand potential in adopting the trials of this latest concept. With the help of NASA, the United States Department of Agriculture (USDA), the Agricultural Research Service (ARS), is the foremost agricultural research association in the biosphere, with further 2000 experts accompanying agrarian study in more than 90 sites around the United States and three extraneous nations [16]. Below are some AI-enabled research areas in agriculture which AI solutions could address.

A. Production Management

Agriculture has a tremendously complicated supply chain. AI is changing the way we produce, distribute, and consume food. Academics are by means of AI-driven skills to stipulate acquaintance and direction about yield alternation scheduling, planting epochs, water and nutrient administration, pest supervision, ailment control, fine streaking, food promotion, merchandise circulation, food protection, and other agriculture-related responsibilities during the food supply chain [17].

B. Crop Monitoring

Conventional crop well-being examining approaches are time-exhausting and labor-intensive. AI is a helpful means for observing and detecting possible crop well-being matters or nutrient arrears in the soil. Applications for evaluating plant condition courses in farming are being expanded using deep learning. Such AI-driven apps assist in enhanced learning of soil conditions, plant pests, and plant disorders[16, 17].

C. Food Quality

Regarding food well-being and quality guarantee, computer vision, and Artificial Intelligence play a crucial role. AI lets computers understand from practice, translate information from feedback and outputs, and do most human being tasks with better accuracy and productivity[18].

D. Crop Yield Predictive Analytics

Using AI, NASA remote perception data and weather conditions networks were merged to predict farming productivity and generate over a restricted area. It may also benefit in establishing how much of the crop will be reaped under circumstances. Improvements in AI-centered data analytics aid agriculturalists in safeguarding environmental sources such as earth, atmosphere, and water and lessen the responses essential for good quality yields [19]. AI supports pervasive transformation all the way through pioneering tools that reform farming's determined forms and limitations. AI will lead an agrarian revolt when the globe has to yield more foodstuff with few reserves.

ARS researchers in numerous test centers have used AI tools to stimulate agronomic investigation and has ten logical breakthroughs. Regrettably, many AI-centered agricultural research proposals at ARS could not be adopted due to space limitations [19]. This Special Section has been constructed to be as informative as feasible, comprising data on numerous AI methodologies employed in ARS..

E. Disease Detection

Plant diseases pose a significant danger to the environment, the economy, and food security. Early diagnosis of crop illness is critical for disease management [20].

AI-centered image detection techniques might precisely distinguish particular plant disorders, conceivably overlaying the route for field-based agronomic syndrome finding developing mobile gadgets such as smart phones.

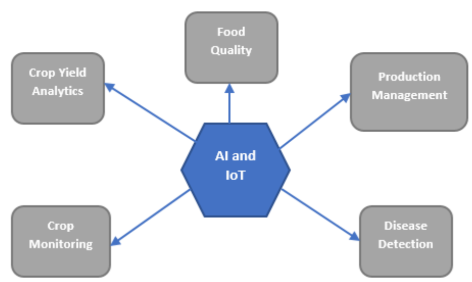

Fig 1. Usability of AI and IoT technology in Agri sectors

III. IoT benefits for agriculture

The advantages of IoT in agriculture include the following:

- IoT makes it simple to gather and organize the vast amounts of data

collected from sensors. When combined with distributed computing services like field maps, distributed storage, and so forth, information can be accessed from any location, enabling real-time communication between all parties involved.
- According to experts, farmers can increase food production by 70% by the year 2050 by using precise sensors and cutting-edge technology, which is why IoT is a crucial component of smart cultivation.
- The costs associated with IoT projects can be drastically reduced, increasing productivity and maintainability.
- Productivity levels about the utilization of soil, water, composts, pesticides, and other resources would increase with IoT. With IoT, other factors would also influence climate and environmental security[21].

IV. Agriculture's Use of Machine Learning

The advantages of machine learning in agriculture are as follows:

- Machine learning makes it possible to implement practical work without wasting resources.
- By comprehending the dynamics present in the ecosystem, machine learning can be very helpful in managing soil quality.
- It can be used to estimate fertilizer needs for crops and plot yield.
- It can monitor crop quality and notify the user immediately if anything impacts crop quality [21].

V. AI and IoT techniques in Soil Management

A. Yield and Crop Management

Based on data obtained via the IoT network from yield observation connected to GPS, ML-based yield planning may be used in farming. The date that collects the yield results will be planned based on the different types of farms[3]. Additionally, ML frameworks and IoT can be used to predict and enhance yields in the farming sector. Farmers primarily rely on rural experts for guidance. Farmers and others use these systems without any knowledge of PC usage. Crop formation can be done utilizing an ML framework. This method for producing information generates data by using already-available data. Farmers now have more freedom to decide on financially secure harvesting strategies. Various such frameworks have been developed in light of the success of master frameworks. The Internet of Things plays a significant role in the agriculture industry. Related research demonstrates that ML frameworks can be based on the IoT and can offer recommendations on how to use information that is continuously gathered [3].

B. Soil Management

Soil management and environmental studies are vital elements of agrarian operations. A comprehensive interpretation of varied soil varieties and circumstances will expand crop production while maintaining soil reserves. It is possible to use ML-centered methods for the soil panel. Info about the soil can be obtained from isolated radar pivots conveyed nearby. At that point, the achieved information can be processed into ML calculations to forecast and break down soil characteristics or purchase the various forms of soil using applied ML computations. Furthermore, the most widespread machine learning (ML) practices, such as K-nearest neighbor, Support Vector Regression (SVR), Naive Bayes, and others, can be used to foresee soil dehydration based

on info on rainfall and evaporative hydrology.

Table 1 beneath delivers an outline of AI soil-controlling techniques. Management-oriented modeling (MOM) lessens nitrate filtering by engendering a compilation of possible administration choices, assessing each option, and defining which choice matches up with the user-weighted compound standards. MOM employs "hill climbing" as a tactical search method, with "best-first" as a preemptive pursuit technique, to decide the quickest pathway from start nodes to targets [24]. Engineering information is acquired in three steps to construct the Soil Risk Characterization Decision Support System (SRCDSS): knowledge acquisition, conceptual design, and system implementation [22].

Application	Technique	Strength	Limitations
[23]	MOM (Management-oriented modeling)	Reduces nitrate stripping and boosts manufacture.	Brings time. It is restricted only to nitrogen.
[24]	Fuzzy Logic: SRC-DSS	Categorize soil corresponding to correlated hazards.	Demands big data. Only a few cases were investigated.
[25]	DSS	Lessens corrosion and alluvial revenue.	Necessitates big data for education.
[26]	ANN	foresees soil moisture and consistency	Involves big data for education. Has limitations in areas of operation
[27]	ANN	Can approximate soil nutrients after corrosion	Its valuation is confined to only NH

Table 1. Crop Management Summary

Table 1 encapsulates crop supervision methodologies. Crop management commences with sowing and remains with crop observing, collecting, crop storage, and distribution. It is defined as procedures that encourage agrarian efficiency development and productivity. A thorough comprehension of crop programs centered on their time and flourishing soil form would certainly increase crop manufacture. Precision crop management (PCM) is an agrarian supervision technique that affects crop and soil responses centered on the field needs to expand effectiveness while safeguarding the natural ecosystem.

B. Research Questions

This study creates a unique research design by incorporating components from the value-based adoption and technology acceptance models. The authors apply the service-dominant approach to their research by connecting several perceived value factors with AI and IoT technologies. They investigate how trust influences perceived value and risk and how perceived value and risk influence IoT adoption. The authors put their predictions to the test by using a structural equation model to examine the findings of a survey in which 98 farmers from the United States took part.

An in-depth, structured literature review aims to bridge the gap and answer the below-written Research Questions (RQ).

This research study article will answer the below RQs from a future perspective.

RQ1 – What is the proper function of AI in agri-food business models?
RQ2 – What is the new role of stakeholders in promoting AI in all aspects of the Agri-business model?

C. Methodology

A. Research Design

The research approach here employs the qualitative style to emphasize the substance of AI articles and make a viable business prototype. Before conducting the systematic review, a review protocol is well-defined. The research questions are demarcated with proper boundaries. When discussing the main contribution of AI, we detailed and thought through the "social distancing" rule at the time of COVID-19 and the world hence after [28]. This research study's database mainly comprises articles from Scopus and Google Scholar. This research study followed the following steps in identifying the related articles:

- Extraction of articles based on AI on Agri-business and agribusiness models
- Identify the main articles concerning the research topic
- Manually identify the more cited papers in the last five years
- Identify the ones meeting the research topic

This process allowed us to incorporate scientific papers in line with the objective of this investigation. All the parts accumulated were analyzed independently to underline the significant and appropriate characteristics beneficial for this study.

B. Participants

Participants of this research study are agri-business people, agri-researchers, and supply chain people from across the globe. Small-scale and large-scale industries are part of this learning or change process, and the data was collected over the last two months.

Continent	Small Business owners in %	Large business owners in %	Supply chain - Agri in %
Asia	45	30	25
Europe	60	30	10
North America	20	40	40
Africa	60	20	20

Table 2. Participant Demographic Data

C. Data Analysis

After thoroughly analyzing the responses received from all participants, it is evident that everyone supports adding a more efficient technology model for the business to flourish. As findings have indicated below, it continues an expanding appeal from academics and both small-scale and enormous firms to let AI in the situation. At the same time, the attention on "environmental awareness" and "stakeholders" combined with the other keywords is still uncommon. 95% of the result came from stakeholder awareness were 60% urged to move the business model more towards technology-friendly sustainable ideas.

VIII. Results

The results from the study are primarily the aids in the works about embracing AI skills in functioning procedures archetypal in the agri-food subdivision and the investor consciousness to contrivance the similar.

Continent	Support of AI	Stakeholder awareness	Early adoption (Y/N)
Asia	80%	60%	Y
Europe	80%	70%	Y
North America	95%	70%	Y
Africa	65%	40%	N

Table 3: Stakeholder awareness on implementing AI in Agri-model

Though AI is deemed a scientific resolution to enhance the effectiveness and output of the segment, its crucial part is acknowledged in its assumption to promote to attaining investors' aims. The analysis of the contribution of investors and their significance in this practice yet requires to be involved (Kuo and Smith, 2018). We need to think through this in detail before concluding in this regard. The findings in this literature review highlighted the stakeholder awareness and motivation to allow and change the process to have a new agri-ecosystem enabling private and public organizations.

IX. Discussion

The study results are as expected, but I need to figure out the stakeholder interest once the pandemic is over. This research study's findings align with other studies done in the industry. As AI is moving faster with smart contracts [28], The sustainability, liability, ecological, societal, fiscal, and functional concerns associated with the agri-business segment must be adopted independently by different continents. We must highlight that the new space economy and supply chain model depends on other regional and federal perspectives in different geographic regions [27, 28]. Security is a significant concern in all industry types, so the crop sector is not another in this regard [29]. The future crop industry needs AI implementation in core sectors and innovation labs with cyber defense to protect research originality and patents [30].

X. Conclusion

It is unquestionable that agricultural science will aid from AI. This research study considered the data concerning this pandemic and the current geographical scenario. The study has a limitation to only research the articles published related to specific keywords. But in the end, it is essential to highlight that it is an eye-opener for the agri-business to adopt new technologies like AI aggressively but smartly concerning regional rules. While some continents and businesses focus more on the stakeholder value, others concentrate on post-pandemic scenarios, population, and rethinking of business models. The literature review also highlights the protection of consumer safety and the importance of stakeholder values when implementing digital tools for developing and optimizing agri-models. These factors are currently experiencing a powerful influence on customer purchasing power and business sustainability. Future extensions of this work aim to build on the outcomes of this study and focus more on feature selection, geo-political scenarios, and regional agri-laws for improved agri-business models.

References

[1] Di Vaio, A., Boccia, F., Landriani, L., & Palladino, R. (2020, June 14). Artificial Intelligence in the Agri-Food System: Rethinking Sustainable Business Models in the COVID-19 Scenario. MDPI. https://www.mdpi.com/2071-1050/12/12/4851

[2] Dash, B. (2021) REMOTE WORK AND INNOVATION DURING THIS

COVID-19 PANDEMIC: AN EMPLOYERS'CHALLENGE.

[3] S. A. Bhat and N. -F. Huang, "Big Data and AI Revolution in Precision Agriculture: Survey and Challenges," in IEEE Access, vol. 9, pp. 110209-110222, 2021, doi: 10.1109/ACCESS.2021.3102227.

[4]. K. Demestichas, N. Peppes, T. Alexakis and E. Adamopoulou, "Blockchain in agriculture traceability systems: A review", Appl. Sci., vol. 10, no. 12, pp. 1-22, 2020.

[5] A. S. Patil, B. A. Tama, Y. Park and K. H. Rhee, "A framework for blockchain based secure smart green house farming" in Advances in Computer Science and Ubiquitous Computing, Singapore:Springer, pp. 1162-1167, 2017.

[6] N. C. Eli-Chukwu, "Applications of artificial intelligence in agriculture: A review", Eng. Technol. Appl. Sci. Res., vol. 9, no. 4, pp. 4377-4383, 2019.

[7] A. Di Vaio, F. Boccia, L. Landriani and R. Palladino, "Artificial intelligence in the agri-food system: Rethinking sustainable business models in the COVID-19 scenario", Sustainability, vol. 12, no. 12, pp. 48-51, 2020.

[8] E. M. López, M. García, M. Schuhmacher and J. L. Domingo, "A fuzzy expert system for soil characterization", Environ. Int., vol. 34, no. 7, pp. 950-958, Oct. 2008.

[9] M. Li and R. S. Yost, "Management-oriented modeling: Optimizing nitrogen management with artificial intelligence", Agricult. Syst., vol. 65, no. 1, pp. 1-27, Jul. 2000.

[10] S. Tajik, S. Ayoubi and F. Nourbakhsh, "Prediction of soil enzymes activity by digital terrain analysis: Comparing artificial neural network and multiple linear regression models", Environ. Eng. Sci., vol. 29, no. 8, pp. 798-806, Aug. 2012.

[11] H. Song and Y. He, "Crop nutrition diagnosis expert system based on artificial neural networks", Proc. 3rd Int. Conf. Inf. Technol. Appl. (ICITA), vol. 1, pp. 357-362, Jul. 2005.

[12] B. Ji, Y. Sun, S. Yang and J. Wan, "Artificial neural networks for rice yield prediction in mountainous regions", J. Agricult. Sci., vol. 145, no. 3, pp. 249, 2007.

[13] K. Balleda, D. Satyanvesh, N. V. S. S. P. Sampath, K. T. N. Varma and P. K. Baruah, "Agpest: An efficient rule-based expert system to prevent pest diseases of rice & wheat crops", Proc. IEEE 8th Int. Conf. Intell. Syst. Control (ISCO), pp. 262-268, Jan. 2014.

[14] M. Branch, "A multi layer perceptron neural network trained by invasive weed optimization for potato color image segmentation", Trends Appl. Sci. Res., vol. 7, no. 6, pp. 445-455, 2012.

[15] A. Tobal and S. A. Mokhtar, "Weeds identification using evolutionary artificial intelligence algorithm", J. Comput. Sci., vol. 10, no. 8, pp. 1355-1361, 2014.

[16] Linaza, M. T., Posada, J., Bund, J., Eisert, P., Quartulli, M., Döllner, J., Pagani, A., et al. (2021). Data-Driven Artificial Intelligence Applications for Sustainable Precision Agriculture. Agronomy, 11(6), 1227. MDPI AG. Retrieved from http://dx.doi.org/10.3390/agronomy11061227

[17] Kuo, T.-C., & Smith, S. (2018, April 30). A systematic review of technologies involving eco-innovation for enterprises moving towards sustainability. Journal of Cleaner Production. https://www.sciencedirect.com/science/article/pii/S0959652618312484.

[18] Liu, S. Y. (2020). Artificial intelligence (AI) in agriculture. IT Professional, 22(3), 14-15.

[19] Dash, B., & Ansari, M. F. (2022). Self-service analytics for data-driven decision making during COVID-19 pandemic: An organization's best defense. Academia Letters, 2.

[20] Eli-Chukwu, N. C. (2019). Applications of artificial intelligence in agriculture: A review. Engineering, Technology & Applied Science Research, 9(4), 4377-4383.

[21] Ravi, G., Subramaniam, S., Rajesh, R., Nithish, G., & Pradeep, T. (2021). Soil Monitoring and Crop Yield Prediction Using Machine Learning. Turkish Journal of Computer and Mathematics Education (TURCOMAT), 12(11), 5498–5503.

[22] Dash, B., Ansari, M. F., Sharma, P., & Ali, A. (2022). Threats and Opportunities with AI-based Cyber Security Intrusion Detection: A Review. International Journal of Software Engineering & Applications, 13(5), 13–21. https://doi.org/10.5121/ijsea.2022.13502

[23] Li, M., & Yost, R. S. (2000). Management-oriented modeling: optimizing nitrogen management with artificial intelligence. Agricultural Systems, 65(1), 1-27.

[24] López, E. M., García, M., Schuhmacher, M., & Domingo, J. L. (2008). A fuzzy expert system for soil characterization. Environment international, 34(7), 950-958.

[25] Montas, H. U. B. E. R. T., & Madramootoo, C. A. (1992). A decision support system for soil conservation planning. Computers and electronics in agriculture, 7(3), 187-202.

[26] S. Tajik, S. Ayoubi, F. Nourbakhsh, "Prediction of soil enzymes activity by digital terrain analysis: Comparing artificial neural network and multiple linear regression models", Environmental Engineering Science, Vol. 29, No. 8, pp. 798-806, 2012

[27] Kumar, V. P., & Rani, C. S. (2011). Prediction of compression index of soils using artificial neural networks (ANNs). Int J Eng Res Appl, 1(4), 1554-1558.

[28] Dash, B., Ansari, M. F., Sharma, P., & Swayamsiddha, S. (2022). FUTURE READY BANKING WITH SMART CONTRACTS - CBDC AND IMPACT ON THE INDIAN ECONOMY. International Journal of

Network Security and Its Applications, 14(5). https://doi.org/10.5121/ijnsa.2022.14504.

[29] Ansari, M. F. (2021). The relationship between Employee's Risk Scores and the Effectiveness of the AI-Based Security Awareness Training Program. Retrieved February 4, 2022

[30] Sharma, P., Dash, B., & Ansari, M. F. (2022). Anti-phishing techniques – a review of Cyber Defense Mechanisms. IJARCCE, 11(7). https://doi.org/10.17148/ijarcce.2022.11728