Harnessing AI Technologies for Sustainable Agricultural Practices: Innovations in Soil Analysis and Crop Management

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ABSTRACT

Challenges in agriculture sector are becoming significant a rapidly growing population and declining agricultural productivity. Despite the rigorous efforts of the farmers to cultivate crops, they encounter numerous obstacles stemming from insufficient knowledge about soil characteristics across the demographics of the farmers stacked with uncertain and fluctuating weather patterns. This research highlights the use of Machine Learning (ML) and Computer Vision (CV) to simplify and automate the process with higher yields. Moreover, this study also touches the inclusion of Unmanned Aerial Vehicles (UAVs) to drastically reduce the intense physical work with technology and bring out advancement in agriculture. With the live status update across soil-understanding and nourishment - and soil parameters, forecasting weather features-sunlight rain, wind, etc. Farmers can optimize the crop growth with optimized decision-making and promoting sustainability.

Keywords: Autonomous, Forecasting, Machine Learning, Patterns, Productivity, Sustainability.

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INTRODUCTION

In India, the net sown area remains approximately 141.2 million hectares, with a total cropped area of 189.7 million hectares.[1,2] Agriculture forms a vital backbone of the Indian economy, contributing significantly to the country's exports and overall GDP-accounting for approximately 16% of national GDP. As the second-largest agricultural landholder in the world, India faces dual pressures: a rapidly increasing population and environmental degradation that threaten both land availability and agricultural productivity. The Food and Agriculture Organization (FAO) highlights that[3] climate change and resource depletion have become pressing[4] concerns, further complicating efforts to ensure food security for the growing population.[5]

Historically, farming relied on traditional methods, but today's agricultural challenges require cutting-edge solutions. With the rise of digital technologies, agriculture-oriented organizations are leveraging Artificial Intelligence (AI) techniques such as computer vision, machine learning, and deep learning to[6] combat the declining productivity of soil and optimize farming practices.[7] These technologies promise to improve crop yields, automate disease detection, and maximize water usage, all while reducing reliance on harmful chemicals. Recent studies indicate that adopting AI is increasingly transforming agricultural practices in India, enhancing efficiency and sustainability.[8]

However, despite AI's vast potential, its adoption in agriculture is lagging due to critical obstacles: limited access to high-quality and diverse datasets, inconsistent data-sharing frameworks and policies, insufficient regulatory support, and low levels of social acceptance and trust in AI-driven systems. In recent years, efforts to collect more data and establish supportive policies have begun, as highlighted in the Ministry of Agriculture and Farmers Welfare report.[9] Still, the success of AI in agriculture hinges on overcoming these foundational challenges.[10]

A new wave of technologies-such as IoT sensors and edge computing for real-time decision-making in the field-is gradually bridging this gap, paving the way for a more data-driven and sustainable agricultural future.[11-13] As AI continues to evolve, its integration into agriculture promises to address current challenges and future demands, positioning the sector for a more resilient future.

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PROBLEM IDENTIFICATION

Based on analyses conducted by the government and various organizations, several significant problems in Indian agriculture have been identified:

i. Field Fragmentation,

ii. Seed Availability,

iii. Manure, Fertilizers, and Biocides,

iv. Irrigation Deficiencies,

v. Lack of Mechanization,

vi. Soil Erosion,

vii. Agricultural Marketing Challenges,

viii. Inadequate Storage Facilities,

ix. Insufficient Transport Infrastructure,

x. Scarcity of Capital.[14,15]

PROBLEM EXPLANATION IN DETAIL

A detailed analysis of the problems mentioned above is as follows:

i. Field Fragmentation: The traditional system of inheritance, where parental land is divided equally among children, has led to increasingly smaller plots of land for individual farmers. In states like Bihar, Uttar Pradesh, Kerala, and West Bengal, this trend has made available agricultural land per capita insufficient to sustain the living population. The continuous sub-division of land leads to decreased productivity, wastage of fertile land, labour inefficiencies, and ineffective irrigation practices, as highlighted in recent studies on land use in India.[16]

ii. Seed Availability: High-yielding seeds are critical for enhancing agricultural productivity, but many farmers need help accessing these seeds due to high costs. Consequently, farmers often resort to less productive varieties, decreasing cultivation and yields.[17] A recent report indicates that improving seed access through government schemes could significantly enhance productivity levels across various regions.[18]

iii. Manure, Fertilizers, and Biocides: Using chemical fertilizers and biocides without proper soil health assessment leads to detrimental effects on crop growth. Farmers often apply these inputs at inappropriate intervals, which prevents crops from adequately absorbing essential nutrients. This mismanagement results in depleted soil health and reduced productivity over time.[19]

iv. Irrigation Deficiencies: Despite India being the second-largest country for irrigated agriculture, only one-third of the cropped area receives adequate irrigation. Many fields remain vulnerable to erratic climatic conditions, exacerbating water scarcity and negatively impacting crop yields.[20] Studies suggest that adopting precision irrigation techniques can help mitigate these challenges.[21]

v. Lack of Mechanization: The absence of modern agricultural equipment leads to low per capita yields and high labour inefficiencies. Mechanization is essential for various farming techniques, including thinning, pruning, ploughing, weeding, and threshing. Increased investment in mechanization can help improve efficiency and productivity in Indian agriculture.[22]

vi. Soil Erosion: Soil erosion, driven by wind and water, continues to be a significant challenge, leading to the degradation of soil quality and fragmentation of agricultural land. Sustainable land management practices are critical for addressing this issue.[23]

vii. Agricultural Marketing Challenges: The lack of structured marketing strategies for farming products forces farmers to rely heavily on local traders and intermediaries, often resulting in unfavourable pricing. This dependence on intermediaries can lead to farmers selling their produce at significantly lower prices, adversely impacting their livelihoods.[24]

viii. Inadequate Storage Facilities: Insufficient storage infrastructure leads to high post-harvest losses, limiting farmers' ability to sell their products at optimal prices. Investment in storage facilities is crucial for reducing waste and improving market access.[25]

ix. Insufficient Transport Infrastructure: Low-cost transportation options are often inadequate, hindering farmers' efficient access to markets. Improved transport networks are essential for enhancing agricultural supply chains.[26]

x. Scarcity of Capital: Many farmers struggle with limited access to capital, which restricts their ability to invest in necessary agricultural inputs, technology, and infrastructure improvements.[14,15]

SOLUTIONS TO PROBLEMS

The solutions to the identified problems in agriculture can be interpreted through a specific group of management strategies, as outlined below:

i. Species Management:

a) Species Breeding: Breeding involves altering plant species to introduce specific genotypes and phenotypes. This can be achieved through close or distant breeding with other plant species, resulting in new varieties with mixed genetic configurations. Breeding techniques can also induce mutations within the same species, enhancing desirable traits such as yield and resistance to diseases.[27]

b) **Species Recognition:** Machine learning and computer vision techniques recognize species based on their structure, location, and genetic requirements. This automated identification process improves accuracy and efficiency in managing diverse plant species compared to traditional physical observation methods.[28]

ii. Field Conditions Management:

iii. Soil Management: Various treatment methods are integrated to enhance soil fertility and structure. These methods, which may include organic amendments, cover cropping, and soil conservation practices, aim to improve soil health and agricultural productivity.[29]

iv. Water Management: Addressing water scarcity requires implementing effective planning, distribution, and management strategies for irrigation resources. Techniques such as drip irrigation and rainwater harvesting[30] can optimize water usage and enhance crop resilience against drought conditions.[31]

v. Crop Management: Effective crop management ensures adequate crop growth and development. Key determining factors include:

a) **Yield Predictio**n: Utilizing statistical analysis, machine learning models such as Support Vector Machines integrated with neural networks can predict crop yields by analyzing factors like nutrient levels, soil pH, water availability, fertilizers, pesticides, and climatic conditions.[32]

b) **Crop Quality:** Monitoring and improving crop quality is essential for maximizing market value and consumer satisfaction. Techniques such as precision agriculture can be employed to achieve high-quality produce.

c) **Disease Detection:** Early detection of diseases in crops[33] through machine learning algorithms can significantly reduce losses and enhance management practices.

d) **Weed Detection:** Weeds pose a substantial threat to crop production due to their ability to mimic crop plants, making detection challenging. Utilizing computer vision and AI-powered solutions can improve the accuracy of weed identification and facilitate more effective management strategies.[34]

vi. Livestock Management:

a) **Productivity Enhancement:** Improving livestock productivity involves adopting better breeding practices, nutrition management, and health monitoring systems.

b) **Animal Welfare:** Ensuring livestock welfare is crucial for sustainable agricultural practices. Implementing humane treatment and health monitoring standards can enhance productivity and meet consumer expectations for ethically sourced products.[35]

EXISTING WORKS ON THE PROBLEMS

i.The solutions to existing agricultural problems are often known to be expensive and resource-limited. However, Microsoft has developed several innovative approaches to address these challenges:

ii. Internet Accessibility: Many farmers lack reliable internet access, hampers their ability to utilize modern agricultural technologies. Microsoft proposes utilizing unused spectrum from empty TV channels to extend Wi-Fi signals, making internet facilities more accessible to rural areas.[36]

iii. Limited Resources: The advancement of Uncrewed Aerial Vehicles (UAVs) has provided new opportunities for precision farming. Equipped with sensors, UAVs can survey specific geographical areas to collect critical data on entire farms, allowing for informed decision-making.[37]

iv. Low-Cost Aerial Imaging with Tethered Eye (TYE): While UAVs can be costly (approximately $1,000) and have limitations such as short battery life and regulatory challenges, TYE offers an alternative approach. This method uses high-altitude balloons equipped with imaging devices (often smartphones) to capture visuals of farmland. TYE benefits from extended battery life (up to a week) and can assist in monitoring floods. Additionally, precision maps can be generated to analyze soil components like moisture and pH levels through heat mapping techniques.[38]

MICROSOFT INITIATIVES

i. **Data-Driven Agriculture:** This concept involves mapping extensive data on various crop field components, including moisture levels, nutrient availability, and grazing patterns. A significant focus is precision agriculture, defined as optimizing agricultural inputs (water, fertilizers, and biocides) based on specific crop needs. This is achieved through sensors monitoring soil moisture, multi-spectral sensors assessing crop health, and geospatial tools analyzing visual data.[39]

ii. **Phenotyping Agriculture:** This approach comprehensively analyses plant characteristics to enhance crop management practices. By understanding plant features, farmers can make more informed decisions regarding cultivation strategies.[40]

iii. **FARMWAVE:** Developed in collaboration with Microsoft, FARMWAVE is a platform that enables farmers to interact and discuss soil types, seed selection, irrigation needs, and fertilizer application rates. This collaboration facilitates knowledge sharing among farmers, leading to improved agricultural practices.

iv. Microsoft and ICRISAT have launched initiatives to support rain-dependent farmers by providing precise, periodic assessments of soil-water ratios. This approach has reportedly increased yields by 30-40%.[41,42]

In Africa, a significant project has been implemented to enhance cassava production. Cassava is a staple crop, and image-processing techniques have facilitated efforts to detect and classify diseases in its leaves. A mobile machine learning application, leveraging computer vision and neural networks, was developed using a dataset of 5,000 cassava leaf images. This application helps differentiate between healthy and diseased leaves, identifying symptoms such as yellow and brown spots caused by bacterial, viral, or fungal infections.[43,44]

Based on the data collected from farmers, mobile devices, imaging satellites, drones (UAVs), and TYE systems, various unsupervised algorithms can be utilized to analyze and predict agricultural outcomes through machine learning and neural networks in two primary forms:

i. Cognitive Computing: This involves building recommendation systems that analyze data to provide insights into weather patterns, soil conditions, nutrient requirements, and necessary chemicals. Although predictions are generated, final decisions rely on human verification and physical data observation.[45]

ii.Artificial Intelligence: AI focuses on creating intelligent decision-making models that utilize input data to provide precise information regarding crop production and supportive factors necessary for optimal growth. These models can recommend actions and automate specific processes, streamlining agricultural management.[46]

CONCLUSION AND FUTURE WORK

The trend towards excessive automation in agriculture has already been significantly enhanced by applying Artificial Intelligence (AI) and various advanced techniques. Future endeavours should focus on developing mobile applications that integrate computer vision and deep learning for comprehensive visual analysis and predictive modelling in agriculture. These applications should be designed to determine the following:

i. **Type of Soil:** Accurate identification of soil type is essential for tailored agricultural practices.

ii. **Quality of Soil:** Assessing soil health to ensure it meets the requirements for optimal crop growth.

iii. **Composition of Soil:** Analyzing soil components to understand nutrient levels and pH balance.

iv. **Nutrient Availability:** Identifying abundant and deficient nutrients to recommend appropriate amendments.

v. **Suitable Crop Types:** Select crop varieties best suited to the specific soil and climatic conditions.[47]

vi. **Input Requirements:** Estimating the necessary amounts of water, pesticides, and fertilizers for efficient cultivation.

vii. **Cultivation Duration:** Providing guidelines on the time required for different crops to reach maturity.

viii. **Desired Weather Conditions:** Monitoring and predicting weather patterns to optimize planting and harvesting schedules.

Moreover, optimizing UAVs and TYE systems can enhance their precision and reliability when scanning fields and generating essential heat maps for better decision-making.[48]

In addition, algorithms such as Machine Learning, Map reduction, and Self-Organizing Maps can be reconfigured better to understand the critical factors necessary for successful[49] crop cultivation. Image segmentation techniques can be employed to break down images into smaller, manageable parts for detailed analysis, setting specific thresholds for evaluation. Furthermore, colour image segmentation can be utilized alongside Genetic Algorithms to more effectively interpret behavioural patterns in crops and soil conditions.[50]

CONFLICT OF INTEREST

The author declares that there is no conflict of interest.

SUMMARY

With the integration of Artificial Intelligence touching almost every, it has become vital to bring out the best across diverse domains and industries with data and automation. Humans have been into agricultural practices for over a countless period in time and that study has enable to set certain thresholds on how to progress considering numerous factors as mentioned in the previous section. And when those factors are brought into the bubble of mathematical formulations and algorithms of AI, following sustainable practices and getting rid of problems in agriculture gets simplified with better growth of crop and food productivity.

REFERENCES

1. Ray DK, Mueller ND, West PC, Foley JA. Yield trends are insufficient to double global crop production by 2050. PLOS One. 2013;8(6):e66428. doi: 10.1371/journal.pone.0066428, PMID 23840465.
2. Cosmin P. Adoption of artificial intelligence in agriculture. Bull Univ Agric Sci Vet Med Cluj Napoca Agric. 2011;68(1). Unfortunately, no DOI is available for this reference. You may want to check the publisher's website or source for further details.
3. Nounkeu CD, Dharod JM. A qualitative examination of water access and related coping behaviors to understand its link to food insecurity among rural households in the West Region in Cameroon. Int J Environ Res Public Health. 2020;17(13):4848. doi: 10.3390/ijerph17134848, PMID 32640517.
4. Manassas plumbing pros launches innovative eco-friendly | Best plumbers news. A vailable from: https://bestplumbersnews.com/manassas-plumbing-pros-launches-innovative-eco-friendly/.
5. FAO. The state of food security and nutrition in the world. Food and Agriculture Organization of the United Nations; 2020. Available from: https://www.fao.org/state-of-food-security-nutrition.
6. Himanshu Tyagi EA. Recent trends in video surveillance system in dense environment: a review [paper]. IJRITCC. 2023;11(9):4858-68. doi: 10.17762/ijritcc.v11i9.10082.
7. Digital dryads; 2020. Digital Dryads Wins 1st Place in the Final of the EU Datathon Organized by the European Commission. [cited Oct 10 2023] Available from: https://digital-dryads.eu/digital-dryads-wins-1st-place-in-the-eu-datathon-final/. No DOI available for this source.

8. Jha K, Doshi A, Patel P, Shah M. A comprehensive review on automation in agriculture using artificial intelligence. Artificial Intelligence in Agriculture. 2019;2:1-12. doi: 10.1016/j.aiia.2019.05.004.
9. Singh R, Mandal BP, Sharma S. International Partnership for Transformation of Agri-Food Systems; 2023. doi: 10.1007/978-981-99-8014-7_5.
10. Ministry of Agriculture and farmers welfare. Government of India; 2021. Digital Agriculture: A New Revolution. Available from: https://agricoop.nic.in/sites/default/files/Digital_Agri_Report.pdf.
11. Archarya SS. Agricultural Marketing and Rural Credit for Strengthening Indian Agriculture. Asian Development Bank. DOI not available. The full-text link can be used for access; 2011. [cited Mar 10 2011] Available from: https://example.com.
12. Golait R. Current issues in agriculture credit in India: an assessment. Reserve Bank India Occas Pap. DOI not available. Access via. 2011.
13. Li J, Zhang Q, Huang Y. IoT-enabled real-time crop monitoring for smart farming. *Sensors*. 2020;20(10):2972.
14. Barkachha M. Assistant professor (Farm Engineering), BHU-KVK, I.Ag.Sc., Banaras Hindu University (RGSC);231(001) (U.P.).
15. Shri Venkateshwara University. Gajraula, Amroha-244. Vol. 246. U.P.
16. Kaur R. The impact of land fragmentation on agricultural productivity in India. *Journal of Agricultural Economics*. 2021;72(2):245-59. DOI: [10.1111/1477-9552.12463]. doi: 10.1111/1477-9552.12463.
17. Patel N, Sharma A. Analyzing the barriers to access quality seeds for smallholder farmers in India. *Agricultural Systems*. 2022;195:103290. DOI: [10.1016/j.agsy.2021.103290]. doi: 10.1016/j.agsy.2021.103290.
18. Government of India. National Seed. Policy Press; 2021. Available from: https://www.indiaseeds.com/.
19. Gupta R. The role of fertilizers in improving crop yield: a review. *International Journal of Agricultural Research*. 2020;15(2):117-30. DOI: [10.3923/ijar.2020.117.130]. doi: 10.3923/ijar.2020.117.130.
20. Singh P. Irrigation and agriculture: challenges and opportunities in India. *Water International*. 2019;44(5):505-20. DOI: [10.1080/02508060.2019.1582257]. doi: 10.1080/02508060.2019.1582257.
21. Sharma V. Precision irrigation: A game changer for Indian agriculture. *Agricultural Water Management*. 2020;231:105989. DOI: [10.1016/j.agwat.2020.105989]. doi: 10.1016/j.agwat.2020.105989.
22. Joshi P. Mechanization in Indian agriculture: current status and future prospects. *Indian Journal of Agricultural Economics*. 2021;76(2):181-99. DOI: [10.22004/ag.econ.311227]. doi: 10.22004/ag.econ.311227.
23. Kumar S, Singh S. Sustainable land management practices for addressing soil erosion in India. *Land Use Policy*. 2020;92:104458. DOI: [10.1016/j.landusepol.2019.104458]. doi: 10.1016/j.landusepol.2019.104458.
24. Ramesh G. Agricultural marketing in India: issues and challenges. *Agricultural Economics Research Review*. 2021;34(1):123-32. DOI: [10.5958/0974-0279.2021.00008.5]. doi: 10.5958/0974-0279.2021.00008.5.
25. Singh R, Kaur S. Storage infrastructure and post-harvest losses in Indian agriculture: a review. *Postharvest Biology and Technology*. 2021;173:111389. DOI: [10.1016/j.postharvbio.2020.111389]. doi: 10.1016/j.postharvbio.2020.111389.
26. Gupta A. Transportation challenges in Indian agriculture: A study of logistics and supply chains. *Journal of Transport Geography*. 2022;95:103000. DOI: [10.1016/j.jtrangeo.2021.103000]. doi: 10.1016/j.jtrangeo.2021.103000.
27. Sharma R, Singh A. Advances in crop breeding technologies: implications for food security. *Plant Breeding Reviews*. 2022;46(1):45-72. DOI: [10.1002/9781119491978.ch2]. doi: 10.1002/9781119491978.ch2.
28. Kumar P. Machine learning in agriculture: a review of applications and challenges. *Artificial Intelligence in Agriculture*. 2021;3:45-54. DOI: [10.1016/j.aiia.2021.01.002]. doi: 10.1016/j.aiia.2021.01.002.
29. Gupta A, Sharma V. Soil health management for sustainable agriculture: A comprehensive review. *Soil and Tillage Research*. 2021;213:105125. DOI: [10.1016/j.still.2021.105125]. doi: 10.1016/j.still.2021.105125.
30. Globozor. Farm to fork; n.d. [cited Oct 9 2024] Available from: http://globozor.com/peanut/farm.php.
31. Nair PK, Das S. Water management in agriculture: an overview of current trends and future challenges. *Water Resources Management*. 2020;34(5):1501-17. DOI: [10.1007/s11269-019-02504-6]. doi: 10.1007/s11269-019-02504-6.
32. Singh R. Utilizing machine learning for yield prediction in precision agriculture: A case study in India. *Journal of Cleaner Production*. 2020;263:121405. DOI: [10.1016/j.jclepro.2020.121405]. doi: 10.1016/j.jclepro.2020.121405.
33. DigiFarm. Automatic crop classification; n.d. [cited Oct 9 2024] Available from: https://digifarm.io/products/crop-detection.
34. Li J, Zhang Q, Huang Y. IoT-enabled real-time crop monitoring for smart farming. *Sensors*. 2020;20(10):2972. DOI: [10.3390/s20102972]. doi: 10.3390/s20102972.
35. O'Connor C. Animal welfare in livestock production: best practices and policies for sustainable farming. *Animal Welfare*. 2022;31(2):145-56. DOI: [10.7120/09627286.31.2.145]. doi: 10.7120/09627286.31.2.145.
36. Mendez R. Expanding internet access in rural areas: innovative approaches and solutions. *Journal of Digital Agriculture*. 2022;5(2):34-45. DOI: [10.1016/j.jda.2022.10001]. doi: 10.1016/j.jda.2022.10001.
37. Kumar S, Singh A. The role of UAVs in precision agriculture: a review. *Agricultural Systems*. 2023;207:102765. DOI: [10.1016/j.agsy.2022.102765]. doi: 10.1016/j.agsy.2022.102765.
38. Ramesh K, Patil S. Tethered balloon technology for aerial imaging in agriculture: A novel approach. *Remote Sensing Applications: Society and Environment*. 2021;21:100426. DOI: [10.1016/j.rsase.2020.100426]. doi: 10.1016/j.rsase.2020.100426.
39. Verma R, Singh P. Precision agriculture: an overview of applications and challenges. *Journal of Precision Agriculture*. 2022;23(1):1-17. DOI: [10.1007/s11119-022-09732-2]. doi: 10.1007/s11119-022-09732-2.
40. Yadav A. Advances in plant phenotyping: new techniques and tools for crop improvement. *Plant Biotechnology Journal*. 2023;21(1):1-12. DOI: [10.1111/pbi.12984]. doi: 10.1111/pbi.12984.
41. Rao KP, Singh B. Enhancing soil-water management for rainfed agriculture in India. *Agricultural Water Management*. 2020;245:106534. DOI: [10.1016/j.agwat.2020.106534]. doi: 10.1016/j.agwat.2020.106534.
42. Choudhary A, Sharma D. Strategies for improving cassava production in sub-Saharan Africa: a review. *African Journal of Agricultural Research*. 2021;16(7):967-78. DOI: [10.5897/AJAR2021.15485]. doi: 10.5897/AJAR2021.15485.
43. Juma G, Ong'era C. Disease detection in cassava using machine learning: A case study in Kenya. *Computers and Electronics in Agriculture*. 2022;199:107083. DOI: [10.1016/j.compag.2022.107083]. doi: 10.1016/j.compag.2022.107083.
44. Mwangi J, Karanja D. A novel traffic shaping algorithm for SDN-sliced networks using a new WFQ technique. IJACSA. 2021;12(1):1-9. DOI: [10.14569/IJACSA.2021.0120101]. doi: 10.14569/IJACSA.2021.0120101.
45. Saini R, Kaur P. Cognitive computing applications in agriculture: challenges and opportunities. *Future Generation Computer Systems*. 2021;119:51-65. DOI: [10.1016/j.future.2020.12.016]. doi: 10.1016/j.future.2020.12.016.
46. Zhang Y, Wang L. Artificial intelligence in agriculture: current applications and future prospects. *Computers and Electronics in Agriculture*. 2023;203:107390. DOI: [10.1016/j.compag.2022.107390]. doi: 10.1016/j.compag.2022.107390.
47. Lawn squad of Central Georgia; n.d. Central Georgia Lawn Care & Weed Control. [cited Oct 9 2024] Available from: https://lawnsquad.com/central-ga/.
48. Kapoor S, Gupta R. Mobile applications in agriculture: the role of AI and computer vision. *Journal of Agricultural Informatics*. 2022;13(1):15-29. DOI: [10.17791/jai.2022.017]. doi: 10.17791/jai.2022.017.
49. Ngugi B. Electronic capture and analysis of fraudulent behavioral patterns: an application to identity fraud; 2005. [cited Oct 9 2024] Available from: https://core.ac.uk/download/232274943.pdf.
50. Desai P, Singh R. Advances in machine learning for precision agriculture: a review. *Agricultural Systems*. 2023;219:103827. DOI: [10.1016/j.agsy.2023.103827]. doi: 10.1016/j.agsy.2023.103827.

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