


Chapter 1

Soil Quality Prediction in Context Learning Approaches Using Deep Learning and Blockchain for Smart Agriculture

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ABSTRACT

The integration of deep learning and blockchain technologies has the potential to revolutionize soil quality prediction in smart agriculture. Deep learning models, like neural networks and convolutional neural networks, enable accurate predictions of soil properties by considering intricate relationships within data. Contextual learning approaches, including embeddings and data fusion, enrich the prediction process by incorporating external factors like weather conditions and land management practices. Blockchain technology ensures secure storage of predictions and data, while smart contracts facilitate automated model execution. This integrated system empowers farmers with accurate predictions for optimal resource allocation and fosters collaboration through decentralized data sharing. Future directions include advancements in deep learning algorithms, blockchain applications, and potential integration with IoT and remote sensing technologies.

DOI: 10.4018/978-1-6684-9151-5.ch001

INTRODUCTION

In recent years, the field of agriculture has undergone a profound transformation driven by technological advancements and the pressing need for sustainable practices. With a growing global population and changing climate patterns, there is an increasing demand for innovative solutions that can enhance agricultural productivity while minimizing resource depletion and environmental degradation (Hanumanthakari et al., 2023; Koshariya, Khatoon, et al., 2023; Selvakumar et al., 2023). Smart agriculture, often referred to as precision agriculture, is emerging as a key paradigm that leverages technology to address these challenges. Within the realm of smart agriculture, one critical aspect is the accurate assessment of soil quality – a fundamental determinant of crop yields and ecosystem health (Durai & Shamili, 2022a).

Soil quality, defined as the ability of soil to perform its functions within an ecosystem, is influenced by a myriad of factors including physical, chemical, and biological properties. Assessing soil quality traditionally involves labour-intensive methods that often yield limited insights due to the spatial and temporal variability of soil conditions (Boopathi et al., 2023; Gnanaprakasam et al., 2023; Jeevanantham et al., 2022). Moreover, conventional methods are time-consuming, expensive, and may not provide real-time data crucial for making informed agricultural decisions. As a result, there is a growing interest in exploring novel approaches that can provide more efficient and precise soil quality predictions (Shahbazi & Byun, 2021).

This chapter sets out to explore the synergy between deep learning techniques and blockchain technology in the context of soil quality prediction for smart agriculture. Deep learning, a subset of machine learning, has demonstrated remarkable success in various domains such as image recognition, natural language processing, and medical diagnosis. Its ability to automatically learn complex patterns from large datasets makes it an attractive candidate for solving intricate problems, including soil quality assessment (Babu & Supriya, 2022; Vyas et al., 2022). Meanwhile, blockchain technology, initially popularized as the underlying technology for cryptocurrencies, offers a decentralized and tamper-resistant platform for secure data storage and sharing. The immutable and transparent nature of blockchain can contribute to enhancing the reliability and integrity of soil quality data (Hossain et al., n.d.; Jadav et al., 2023a). This chapter explores the integration of deep learning and blockchain for soil quality prediction, aiming to bridge the gap between theoretical foundations and real-world applications. It provides insights into technical intricacies, challenges, and potential benefits of this innovative approach. By examining relevant literature, case studies, and conceptual frameworks, readers can gain a holistic understanding of how this amalgamation of technologies can revolutionize soil quality assessment and agriculture (Hossain et al., n.d.; Sumathi et al., 2022).

Agriculture, the backbone of global food production, faces mounting challenges in the 21st century due to factors such as rapid population growth, changing climate patterns, and the need for sustainable resource management. In response to these challenges, modern agriculture is evolving into a data-driven and technology-enhanced domain, with smart agriculture (SA) emerging as a transformative approach (Hassija et al., 2021; Sumathi et al., 2022). At the heart of SA lies the integration of cutting-edge technologies that empower farmers with accurate insights, enabling them to make informed decisions for optimal land management, resource allocation, and sustainable crop production. Among these technologies, deep learning (DL) and blockchain (BC) stand out as pivotal tools that, when harmonized, offer a synergistic solution for one of the fundamental aspects of agriculture: soil quality prediction (Hassija et al., 2021; Jabbar et al., 2020).

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