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Digital Financial Inclusion and Agricultural Credit Scoring Using Artificial Intelligence Based Predictive Models



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Abstract

The integration of Geographic Information Systems (GIS) and Internet of Things (IoT) technologies has significantly transformed the landscape of precision agriculture by providing spatial intelligence coupled with real-time data acquisition. These technologies enable a more targeted, efficient, and sustainable approach to agricultural practices. Applications of GIS-IoT systems span a wide range of precision-driven tasks such as crop health monitoring, soil nutrient analysis, intelligent irrigation management, early pest detection, and predictive yield estimation. By leveraging high-resolution spatial data and continuous sensor feedback, these applications empower farmers to make data-informed decisions, thereby enhancing productivity while conserving critical resources. The synthesis of these technological advancements aligns agricultural operations with modern sustainability goals, addressing global challenges related to food security, environmental conservation, and climate resilience. As precision agriculture continues to evolve, the strategic application of GIS-IoT systems will play a central role in shaping the future of data-driven agricultural enterprise.

Keywords: GIS, IoT, Precision Agriculture, Crop Monitoring, Soil Analysis, Irrigation Management, Pest Detection, Yield Prediction, Real-Time Data, Sustainable Farming, Spatial Data, Decision Support Systems

Introduction

The convergence of Geographic Information Systems (GIS) and Internet of Things (IoT) technologies represents a transformative advancement in the field of precision agriculture [1]. As global food demand continues to rise amidst environmental constraints and resource limitations, precision agriculture has emerged as a critical approach to enhancing productivity, optimizing resource use, and promoting sustainability [2]. GIS provides the spatial intelligence necessary for understanding the geographic variability of farmlands, while IoT offers continuous, real-time data from distributed sensors embedded in the agricultural environment [3]. The combination of these two technologies enables stakeholders to transition from traditional [4], intuition-based farming methods to data-driven agricultural management practices that improve both efficiency and environmental stewardship [5].

GIS-IoT systems play a pivotal role in crop health monitoring, allowing farmers to assess the physiological status of crops with unprecedented precision [6]. IoT-enabled sensors capture real-time data on environmental conditions such as temperature, humidity, and soil moisture, while GIS visualizes and analyzes this data in relation to the spatial characteristics of the farmland [7]. Satellite imagery and drone-based sensors further enhance monitoring capabilities by providing detailed vegetation indices and spectral signatures indicative of crop vigor [8]. These integrated systems enable timely interventions [9], such as nutrient application or pest management, reducing the risk of crop failure and optimizing yield outcomes [10].

Soil analysis represents another critical application area of GIS-IoT integration in precision agriculture [11]. Understanding the variability of soil properties, including pH levels, nutrient content, and water-holding capacity, is essential for implementing site-specific management practices [12]. IoT-based soil sensors continuously collect these parameters, which are then spatially mapped using GIS tools to produce detailed soil fertility maps [13]. Such maps facilitate variable rate application of fertilizers and soil amendments, promoting efficient input usage, minimizing environmental contamination [14], and ensuring that each portion of the field receives precisely what it requires for optimal crop growth [15].