Chapter 1
Quantum Computing for Sustainable Agriculture: Essentials and Prospects

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ABSTRACT

Globally due to growing population and climatic changes intensifies and ensures food security for sustainable agriculture. Traditional agriculture has several challenges like, resource allocation, precise monitoring and crop production. Quantum computing has opened up new avenue in the agricultural field. The potential use of quantum computing in transforming agriculture practices is to enhance sustainable crop management and yield, precision farming, optimizing resource and data security are set to revolutionize every aspect of farming. This innovation has bought a new perspective to integrate crop and livestock farming to high productivity, control pests and diseases and risks. The integration of quantum computing into agriculture is not only support for increasing yields and earnings rather it plays a key role in economic revolution and environmental friendly. This chapter explores the overview, optimization algorithms, applications and prospects of quantum computing for Sustainable Agriculture.

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1. INTRODUCTION

In recent years, worldwide population is increasing significantly while preserving natural resources and extenuating environmental impact. In order to meet the growing food demands sustainable agriculture is essential. As conventional computational tools have certain restrictions in solving complex, large-scale agricultural disputes. The United Nations statistics depicts that the global population has increased from 2.5 billion in the to 8 billion. By 2050, predictions there a rise to above 9.7 billion people while in 2080 it is about 10.4 billion. In addition, Sadigov reports that the 20 percent climb in global population is due to the progress of human society, economy and healthcare, as well as a broad spectrum of factors, human lifespan, high urbanization, migration and fertility rates. Further WHO statistics says that in 2021, 2.3 billion people experienced food insecurity, with up to 828 million facing hunger. To address food insecurity and to meet the rising demand for food requires modern agriculture to increase its productivity levels (Pasupuleti, 2025).

The blending of quantum computing and agriculture has a potential to provide new solutions to longstanding problems in crop production optimization and resource management. With the rise in population farmers are in pressure to boost output while reducing resource practice. Quantum computing is a revolutionary technology rising as a transformative potential. By influencing the principles in quantum mechanics, quantum computers process infinite datasets and resolve elaborate optimization problems much faster than traditional computers. In the case of agricultural field, this is applied for climate modeling, crop yield, crop prediction, soil quality, water management, pest control and supply chain optimization. With the integration of quantum algorithms with precision agriculture, Internet of Things (IoT) enabled farming structure facilitates real-time decision-making and resource efficiency. While still in its budding stage (Maraveas et al., 2024).

The connection of quantum computing and sustainable agriculture grasp enormous promising for lashing innovation, civilizing resilience, and sustaining the development of data-driven, eco-friendly farming practice. The insertion of smart computing designs in the farming strategy extensively facilitates the curbing of challenges that contribute to poor agricultural outcomes and food shortages due to less yields. By including quantum computing in farming initiatives leverage quantum fact as entanglement and superposition that provides computing efficiency, speed and accuracy (Abbas et al., 2021).

Quantum Computing for Financial Modelling: Transforming Predictive Analytics and Trading

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