Chapter 7
Real-Time Soil Moisture Monitoring Using Wireless Sensor Networks for Precision Agriculture

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ABSTRACT

The necessity for precise measurement of soil moisture across spatial and temporal scales, particularly for agricultural purposes, has driven the development of various methodologies for assessing soil moisture content. In recent times, wireless soil moisture sensor networks have emerged as a notable advancement in this field. These networks facilitate the real-time observation of soil moisture, bridging the gap between localized and regional-scale measurements. This chapter is dedicated to exploring different Wireless Sensor Networks (WSN), their applications in agriculture, and their significance in precision irrigation. Furthermore, we delve into the utilization of a Crossbow ēKo® Pro-Series WSN for gathering soil water potential data. The objective of these measurements is to monitor soil water potential under diverse soil management systems. In conclusion, the methodology employed

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for assessing soil water potential through wireless sensor networks has proven to be appropriate and effective, establishing it as a valuable tool for implementing precision agriculture systems.

1. INTRODUCTION

1.1. Classification of Irrigation Methods

Agriculture stands as a cornerstone of global food production and economic prosperity, catering to the burgeoning demands of the world's population while significantly contributing to national gross domestic products (Salem et al., 2024). The vitality of this sector hinges on the availability of water resources, as crop cultivation is inherently reliant on adequate water supplies (Abioye et al., 2020). However, the escalating scarcity of freshwater poses formidable challenges to food security and sustainable development globally. Ensuring the efficient utilization of water resources is imperative for advancing sustainable development and realizing the objectives outlined in the 2030 Agenda for Sustainable Development, particularly in regions with developing economies. Addressing these challenges necessitates the efficient utilization and conservation of water resources, particularly in irrigation practices, to bolster food production while averting water scarcity crises (Tsang and Jim, 2016).

Rainfall and conventional irrigation serve as primary water sources for agriculture. However, the unpredictability of rainfall and the potential adverse effects of excessive or insufficient water supply underscore the importance of controlled irrigation systems (Salem et al., 2023). These systems, crucially, provide a regulated approach to watering crops, ensuring optimal conditions for plant growth and development (Shibusawa, 2001; Oborkhale et al., 2015).

Various irrigation methods, depicted in Figure 1, can be employed to deliver water to plants. These methods are broadly categorized into traditional and modern techniques based on their efficiency in water conservation, precision monitoring, scheduling, and control. The amount of irrigation water required for any plant is influenced by the chosen irrigation method, plant water demand, and soil type. Moreover, the selected irrigation methods significantly impact nutrient distribution, infiltration rate, evaporation rate, water absorption pattern, and deep percolation of the soil.

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