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## Optimizing Agricultural Yield in Agriculture 5.0: Exposing AI and IoT Driven Irrigation Gaps

### Communication Info

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### Abstract

The promise of Agriculture 5.0 hinges on integrating AI and IoT to boost crop yields through smart irrigation [1][2]. While Deep Reinforcement Learning (RL) shows impressive potential—reporting 29% water reduction in simulation [3]—translating this to the field remains challenging due to the "sim-to-real" gap [2][4]. A core issue is the sparse-action, delayed-reward nature of irrigation, which complicates RL credit assignment [2][3]. Additionally, models often ignore real-world sensor noise and hardware faults, degrading performance by up to 30% [2], and relying on averaged sensor data is insufficient when spatial non-uniformity is a factor [2]. Current simulations also neglect complex multi-objective trade-offs like energy and sustainability [2], with simple reward functions sometimes ignoring long-term plant health for short-term gains [2], while the high computational costs of RL exclude smallholders [2]. Although Digital Twins could bridge this divide [5], their current cost and complexity limit widespread adoption [5]. This article proposes a conceptual framework integrating IoT data collection, digital twin simulation, and multi-objective reinforcement learning to address real-world irrigation challenges in the context of Agriculture 5.0.

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