

Intelligent Crop Circle: A Blockchain-Driven, IoT-Based, AI-Powered Sustainable Agriculture System

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Abstract : Conceived as a high-end engine to revolutionise sustainable agri-food production, the intelligent crop circle (ICC) aims to incorporate the Internet of Things (IoT), blockchain technology and artificial intelligence (AI) to bolster resource efficiency and prevent waste, increase the volume of production and bring about sustainable solutions with long-term ecosystem conservation as the guiding principle. The operating principle of the ICC relies on bringing together multidisciplinary bottom-up collaborations between producers, researchers and consumers. Key elements of the framework include IoT-based smart sensors for sensing soil moisture, temperature, humidity, nutrient and air quality, which provide short-interval and timely data; blockchain technology for data storage on a private chain, which maintains data integrity, traceability and transparency; and AI-based predictive analysis, which actively predicts resource utilisation, plant growth and environment. This data and AI insights are built into the ICC platform, which uses the resulting DSS (Decision Support System) outlined as help in decision making, delivered through an easy-touse mobile app or web-based interface. Farmers are assumed to use such a decision-making aid behind the power of the logic informed by the data pool. Building on existing data available in the farm management systems, the ICC platform is easily interoperable with other IoT devices. ICC facilitates connections and information sharing in real-time between users, including farmers, researchers and industrial partners, enabling them to cooperate in farming innovation and knowledge exchange. Moreover, ICC supports sustainable practice in agriculture by integrating gamification techniques to stimulate farm adopters, deploying VR technologies to model and visualise 3D farm environments and farm conditions, framing the field scenarios using VR headsets and Real-Time 3D engines, and leveraging edge technologies to facilitate secure and fast communication and collaboration between users involved. And through allowing blockchain-based marketplaces, ICC offers traceability from farm to fork - that is: from producer to consumer. It empowers informed decision-making through tailor-made recommendations generated by means of AI-driven analysis and technology democratisation, enabling small-scale and resource-limited farmers to get their voice heard. It connects with traditional knowledge, brings together multi-stakeholder interactions as well as establishes a participatory ecosystem to incentivise continuous growth and development towards more sustainable agro-ecological food systems. This integrated approach leverages the power of emerging technologies to provide sustainable solutions for a resilient food system, ensuring sustainable agriculture worldwide.

Keywords : blockchain, internet of things, artificial intelligence, decision support system, virtual reality, gamification, traceability, sustainable agriculture

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