

# Digital Twins of Smart Farms

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## Abstract

*In recent years, the development of Digital Twins has made rapid progress, and Digital Twins has gradually begun to combine various fields and applied to the current digitalization of the physical world. Digital Twins can play an important role in agriculture. Digital Twins can fully improve the yield and income of crop products and solve the problems of food security. In this paper, the development prospect of Digital Twins in agriculture is discussed.*

**Keywords:** Agriculture; Digital Twins; Virtual Reality; Artificial Intelligence; Blockchain.

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## 1. Introduction

According to a report by the Global Network on Food Crises [1], at least 155 million people in 55 countries were exposed to acute food insecurity at crisis level or worse in 2020, an increase of about 20 million over the previous year. The main reasons include conflicts, economic shocks caused by COVID-19, and extreme weather. In addition, at present, global agriculture is also facing many problems, such as the loss of rural population, which make agricultural development is blocked. There are also problems of resource waste and environment pollution in agricultural production. Food safety problems occur frequently, and the traceability of agricultural production process is highly anticipated. These problems urgently need us to make a major change in agricultural production mode, and the combination of Digital Twins and agriculture cannot be ignored to solve the above problems. The emergence of Digital Twins enables farmers and stakeholders to respond to unexpected situations [VTBW21]. By constantly monitoring the entire process from production to marketing and sales, it can help identify problems in advance, schedule predictive maintenance and immediate solutions to complex problems at the right time [POA21].

## 2. Artificial Intelligence Predicts Plant Growth

Plant growth regulation mostly relies on the comprehensive development of a variety of science and technology such as organic synthesis, microanalysis, plant physiology, and biochemistry. The growth of plants from seed germination, leaf growth to flowering, and fruiting are currently mostly artificially observed. It is difficult to predict the growth trend of plants in a comprehensive, specific, and uniform manner.

Digital Twins farm can use sensors to accurately monitor the chemical composition in the soil, soil moisture and various dynamic data in the field such as wind direction, wind, rainfall and

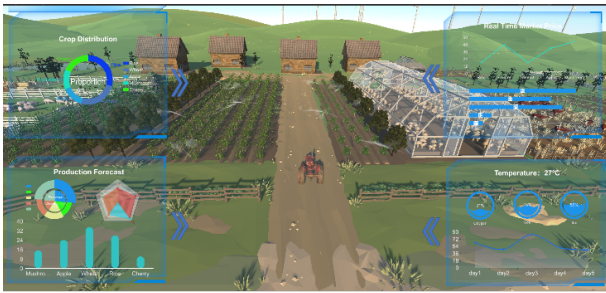
light. According to the real-time monitoring of market data, soil, weather conditions, the growth and development of crops, accurately predict growth and income of the crop yield, to achieve a full range of automatic control of crop products [YGM]. As shown in Figure 1, we can see the above information. Besides, timely early warning should be given to natural disasters. In the event of natural disasters, protective measures should be taken for crop products in the first time, and corresponding emergency measures should be taken to deal with different natural disasters such as insect infestations, snow disasters and floods. Through precise detection and intelligent analysis, crop products should be protected from natural disasters.

Based on the related monitoring of crop products in the smart farm, the prediction of market Big Data models, and the intelligent adoption of measures to respond to natural disasters, an intelligent analysis layer for environmental perception is constructed, and the data provided by the infrastructure layer is uniformly calculated, stored, analyzed, tested and accepted, etc. Through the real-time analysis of Big Data, artificial intelligence technology can solve problems such as the inability to control the future growth of crops, to achieve the stage of maximizing total revenue [WLZ\*20].

## 3. Virtual Reality of 3D Farm

The existing smart farms do not only need to remotely control machines, they can sow, irrigate, and harvest their 10,000 mu of fertile land. In meeting the needs of food production, farmers still have to face various challenges every day, and the frequency of manual labor is still too numerous to list.

The Digital Twins smart farm uses Simulation to build a three-dimensional Digital Twins farm, which simulates the true growth of crops and establishes a digital model of the multi-faceted living environment of crops. In the three-dimensional Digital Twins farm,



**Figure 1:** Real-time Monitoring of Smart Farm.

it can realize remote control of precise insect and weed control. It also can perform irrigation and fertilization based on real-time monitoring data timely and automatically, and simulate crop protection measures according to weather and seasonal changes. As a result, Digital Twins farm respond to real-time changes in weather conditions and soil level, reduce costs and environmental pollution, while improving the effectiveness of medicines and fertilizers, as well as generate corresponding automatic solutions based on the growth and development of crops in real-time [PBP\*21].

Through Virtual Reality to simulate the real farm conditions, a highly automated, integrated, mechanized, and integrated smart farm can be realized. All-round automated sowing, irrigation, de-worming, weeding, and harvesting can be combined in the field of Digital Twins and agriculture.

#### 4. Blockchain Realizes Supply Chain Management

At present, food safety issues are still in a state of the urgent need to be resolved. Food needs to go through multiple processes from the place of production to the consumer's table. In this process, due to poor control of harvest and processing time and encounters bad weather, or the use of unqualified packaging materials. As well as many factors will cause the product to rot, deteriorate, or be contaminated or polluted. Product safety issues are becoming more serious. Resulting in lower sales of agricultural products, consumers cannot assured that they can eat agricultural products. However, Blockchain can be used to solve these issues.

Digital Twins Farm provides comprehensive management of the supply chain of agricultural products, enabling customers to trace the growth and development information of any agricultural product by scanning the QR code shown in Figure 2. It can determine whether the quality of purchased agricultural products meets the requirements. According to Blockchain, the production chain can be supplied. Combined with the results of big data analysis of historical data, forecast the demand of certain agricultural products in the future market. Then Combined with the demand for this agricultural product in a fixed area as a unit. According to the real-time feedback of the unit's various land characteristics, the most suitable land in the unit of agricultural products can be chosen to plant corresponding agricultural products type. Therefore, to achieve the goal of maximizing increase the total income of agricultural products [AC14].

Before the crop products are harvested, the output of the crop

products is estimated. Combined with the current market demand information and the market historical demand information, to estimate the future income of the crop products can maximize the benefits. Farmers are provided with application services such as real-time calculation of profit maximization based on the conditions of agricultural products. Through Blockchain, from seeding and growth to processing and production, the supply chain management has greatly increased the safety of edible agricultural products. During the growth and development process recorded by the QR code, it can also protect the rights and interests of consumers, and creating a safe food safety environment [PS06].



**Figure 2:** Traceability of Plant Growth.

#### 5. Conclusion

This paper analyzes the existing problems in the field of agriculture and puts forward the idea of constructing smart farm combining Digital Twins to alleviate these problems. The smart farm can predict plant growth using Artificial Intelligence, simulate 3D farms using Virtual Reality, and manage supply chains using Blockchain. These functions play an important role in reducing the waste of agricultural resources, environmental pollution and ensuring the output and quality of agricultural products, giving full play to the superiority of Digital Twins in solving agricultural problems.

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