

Chapter 4

Digital Twins, Extended Reality, and Artificial Intelligence in Agriculture: Emerging Trends and Insights

Prachi Lokhande

 <https://orcid.org/0009-0007-2869-922X>

*Sanjivani College of Engineering,
Kopargaon, India & Amity University,
Dubai, UAE*


Sanket Mali

*Sanjivani College of Engineering,
Kopargaon, India*

Nilesh Jadhav

*Sanjivani College of Engineering,
Kopargaon, India*

Mudassir Khan

 <https://orcid.org/0000-0002-1117-7819>

King Khalid University, Saudi Arabia

Firas Tayseer Ayasrah

 <https://orcid.org/0000-0002-6477-000X>

Al Ain University, Al Ain, UAE

Korhan Cengiz

Biruni University, Istanbul, Turkey

ABSTRACT

The basis of human civilization, agriculture is changing significantly in response to current digital technologies' inclusion. The possible uses of digital twins, extended reality (XR), and artificial intelligence (AI) in contemporary agricultural operations are investigated in this paper. Dynamic virtual representations of agricultural environments that digital twins may provide enable operational optimization and prediction simulations. Among other uses, XR technologies include augmented reality (AR) and virtual reality (VR) might be utilized for real-time visualization,

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training, and decision-making. Conversely, by use of modern data analytics and machine learning, artificial intelligence might possess strong predictive insights and autonomous capabilities. These technologies taken together provide the basis of a precision-based, data-driven agricultural ecosystem that greatly increases productivity via accuracy, sustainability for agricultural output, and resource efficiency.

1. INTRODUCTION

Farming has always been defined by its determination, creativity, and desire to improve. Since ancient people sowed the first seeds, farming has changed, improved, and grown. It has also grown into the global agribusinesses that exist today. This change has been going on since farming began. Even yet, the stakes are higher now than they have ever been in the past. Farmers all throughout the world are today dealing with more stress and uncertainty than ever before, especially when compared to previous generations (Atmojo & Vyatkin, 2018). Some of the things that have led to this predicament include climate change, a rapidly growing population, a greater demand for food, and fewer people working in rural areas. Still, despite these problems, a new era of chances is on the way. This age is being driven by AI, XR, and digital twins. This new age has come about because these three technologies have come together. Picture a farm where a tractor is more than simply a tool. It is a complicated, networked machine that sends data to a digital counterpart that mimics every action and environmental factor in real time. This is the kind of digital twin that would run the farm. In a digital environment, you can view and interact with the moisture, temperature, crop growth, and equipment condition of the soil. You may also keep an eye on and talk to the crop as it grows. This is not science fiction to me. It has already begun to happen. Farmers may use this digital twin model to spot problems coming, try out several scenarios, and take steps to stop them before they lose even one drop of water or a leaf begins to wilt. Figure 1, which you can see here, shows this. This technology makes it possible to turn intuition into insight by using real-time data and predictive modeling (De Benedictis et al., 2022).

It's time to head out into the field. A farmer may see data that is floating in front of them as they walk through rows of crops using augmented reality glasses. Some of this information is about how much fertilizer to use, how to tell whether a plant is growing, and how to avoid health dangers. This is an example of extended reality in this case. Figure 2 shows that augmented reality lets farmers work better instead of harder for longer periods of time. They can obtain real-time instructions, insights, and updates without ever having to take their phones out of their pockets or leave the field. One important part is the ability to make important decisions more quickly and accurately, while also gaining the confidence that comes with having clear digital

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