Chapter 1
Extended Reality Applications in Agriculture:
Enhancing Efficiency and Sustainability

Rini Adiyattil
Saveetha School of Law, Saveetha Institute of Medical and Technical Sciences, Chennai, India

G. Aswathy Prakash
https://orcid.org/0000-0003-0806-4562
Saveetha School of Law, Saveetha Institute of Medical and Technical Sciences, Chennai, India

S. Thangamayan
Saveetha School of Law, Saveetha Institute of Medical and Technical Sciences, Chennai, India

S. Siddarthan
Saveetha School of Law, Saveetha Institute of Medical and Technical Sciences, Chennai, India

R. Prajit Ram
Saveetha School of Law, Saveetha Institute of Medical and Technical Sciences, Chennai, India

AthibanRam B.
Saveetha School of Law, Saveetha Institute of Medical and Technical Sciences, Chennai, India

Sharmila A
https://orcid.org/0000-0002-9871-3871
Raj Kumar Goel Institute of Technology, Ghaziabad, India

ABSTRACT

Extended Reality (XR), comprising Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), is transforming agriculture by enhancing productivity,

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efficiency, and sustainability. This study explores XR's diverse applications in modern farming, including immersive training, real-time monitoring, and precision agriculture. Using a mixed method approach with global case studies, data analysis, and machine learning, it highlights significant gains in yield, resource use, and farmer training. Integration with AI, IoT, and GIS further strengthens data-driven decision-making and climate resilience. XR emerges not just as a digital tool but as a catalyst for a smarter, sustainable agricultural future.

1. INTRODUCTION

The industrial sector is going through a lot of changes right now, and agriculture is not immune to them. The agriculture business is being hurt by these problems. The extensive usage of digital technology has made it possible for these technologies to cause problems in the industry. "Extended Reality" (XR) is a catch-all phrase that includes Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR). It is one of the most innovative technologies that is changing the way farming is done. XR is a phrase that covers all three of these technologies. XR is a catch-all term that includes three distinct formats. More and more, farms are using these immersive technologies to help meet the growing need for global food security, support environmentally friendly practices, and improve operational efficiency (Arnold et al., 2018). For instance, augmented reality technology is becoming an increasingly effective tool that makes it easier to learn skills like real-time insights, simulated-based training, and data-driven decision-making. These technologies are gaining form as they become more powerful and useful. The agricultural industry is now facing a number of problems, including a lack of available workers, soil deterioration, the effects of climate change, and a decrease in the amount of water that is available (Chen & Konomi, 2022). These are just a few of the problems that the business is dealing with right now. Augmented reality (XR) might change the way farming works by connecting digital information with real-world agricultural settings. This might help cut down on wasted resources and boost production to levels that were once thought to be impossible.

With extended reality, users may now see, touch, and change virtual models and data in ways that were formerly impossible. Computers used to be the only ones that could do this. This breakthrough has been a big step forward for the field of virtual reality. It is still feasible to do a thorough study of the farming practices that are currently in use at this time. Augmented reality solutions, such those that provide crucial information like health indices, soil conditions, and irrigation demands, may be used with smart glasses or mobile devices. These solutions can be quickly overlaid on real fields. There are many ways to use these solutions. When people