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## A REVIEW ON CLIMATE - SMART AGRICULTURE (CSA) FOR CLIMATE CHANGE ADAPTATION: EMERGING TRENDS, BENEFITS, AND CHALLENGES

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**Abstract:** Climate change has become a significant threat to global agriculture, food security, water availability, and ecosystem stability. Besides, conventional Agriculture severely contributes to climate change as greenhouse gas emissions from many current farming practices. In response, climate-smart agriculture (CSA) has emerged as a transformative strategy to reorient agriculture systems through the integration of advanced digital technologies. This systematic review, conducted using PRISMA methodology, aimed to (a) thoroughly investigate the use of CSA practices for resilience agriculture under a changing climate and (b) evaluate its current technologies, benefits, challenges, and future prospects. The review focused on over 45 peer-reviewed, English language publications, published between 2012 to 2024 from 1342 selected articles. Literature search was conducted through the Web of Science, ScienceDirect, Springer and Wiley Online Library databases using keywords such as “climate - smart agriculture,” “climate resilience,” “precision farming,” climate change,” “artificial intelligence,” and “sustainability” with employing Boolean operators (AND, OR) to refine the search results. The findings indicate that smart water and soil management practices, biotechnology and smart cropping systems, priming, integrated pest control and fertility management, genetic engineering, and smart livestock farming was the key CSA adaptive strategies can be integrated with digital technologies, including AI-driven analytics and IoT-based, decision support systems, to mitigate climate change impacts. These technologies enable real-time data collection, predictive analytics, and site-specific management, facilitating optimised resource allocation, reduced environmental degradation, and improved food security. The integration of smart agriculture with sustainable land management can enhance soil health, conserve water resources, and promote long-term environmental sustainability. However, widespread adoption faces challenges such as high implementation costs, lack of technological infrastructure, data privacy concerns, and knowledge gaps among farmers. To overcome these barriers, multi-stakeholder collaboration, government policy support, financial incentives, and farmer education programs are essential. Addressing these challenges will accelerate the adoption of smart agricultural technologies, particularly in climate-vulnerable regions.

**Keywords:** Artificial intelligence; Climate change; Climate resilience; Climate - Smart agriculture; Precision farming; Sustainability