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A review on computer and information technology in agriculture

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Abstract
The paper focuses on the transformative role of computer and information technology in agriculture. this integration has revolutionized the sector, providing online services for information dissemination, education, training, monitoring and transaction processing. E-commerce facilitates direct connections among producers, traders, retailers and suppliers. Communication between researchers, extension workers and farmers is enhanced with question and answer services improving efficiency at the block and district levels. The use of databases, early warning systems and online land records benefits farmers. Livestock rearing and milk production contribute to rural income, supported by information services on farm business and management. Despite significant potential, only a few ICT projects have been initiated, often led by non-governmental organizations and private entities. This paper underscores the need for further research to shape a comprehensive approach for agricultural development through technology.

Keywords: Computer, information technology, database, farmers, communication etc.

Introduction

Agriculture is commonly referred to as the "backbone" of the Indian economy's GDP, engaging over half of the population either directly or indirectly. It not only provides employment opportunities domestically but also contributes to earning foreign exchange from other nations. The current global population of 7 billion, expected to reach 10 billion by 2050, places significant pressure on agriculture and the natural resource base. The escalating demand for food due to population growth gives rise to various environmental issues [1]. The primary challenges faced by agriculture today include:

1. Deforestation and habitat fragmentation endanger biodiversity.
2. Land clearing, crop production, and excessive fertilization contribute to about 1/3 of global greenhouse emissions.
3. Disruption of nutrient cycles, such as nitrogen and phosphorous, negatively impacts water quality, aquatic ecosystems, and marine fisheries.
4. Depletion of fresh water resources, with 80% being utilized for irrigation [2].

These detrimental environmental impacts can be mitigated while maintaining high food production through the adoption of advanced technologies and computer applications. Modern computer applications are widely employed in agriculture and agronomy to monitor agricultural activities. Given the seasonal nature of agriculture, where productivity is influenced by the physical landscape, weather parameters, and management practices, the need for timely monitoring is crucial. Factors like weather conditions, landscape variations, and management practices can rapidly alter productivity. Hence, timely agriculture monitoring is essential for efficient resource utilization and effective productivity enhancement. According to the Food and Agriculture Organization (FAO) in 2011, timeliness is a critical factor in agricultural statistics and associated monitoring systems. Information loses its value if it becomes available too late. Computer applications play a vital role in overcoming these barriers and contributing to agricultural development [3].

Several benefits arise from the application of diverse computer programs and cutting-edge technologies in agriculture, with key advantages including:

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- Furnishing a more punctual and precise overview of agricultural production and productivity.
- Supplying accurate information about extensive areas in a precise manner.
- Offering data on weather parameters for specific regions in a simplified manner.
- Aiding in the identification of vegetation vigor in distinct areas and the ongoing monitoring of drought stress.
- Facilitating the assessment of crop phonological development.
- Assisting in the acquisition of data regarding crop acreage estimation and cropland mapping.
- Mapping disruptions and changes in land use/land cover.
- Supporting the management and control of diseases & pests occurring in defined areas [4].

Despite the prevalent use of scientific technologies in agriculture, information technology plays a pivotal role in this sector. Technologies such as satellite navigation, sensor networks, grid computing, ubiquitous computing, and context-aware computing contribute significantly to enhanced monitoring and decision-making capabilities in agriculture. In the pursuit of a sustainable agriculture system, it becomes evident that emerging innovations can make significant contributions. Noteworthy technologies encompass Smart Agriculture, Precision Agriculture (PA), Variable Rate Technology (VRT), Precision Farming, Global Positioning System (GPS) Agriculture, Farming by Inch, Information-Intensive Agriculture, Site-Specific Crop Management, all of which are sensor-based [5]. These sensor technologies and their networks propel agricultural practices towards progress. Notable technologies include:

- Global Positioning System (GPS): A satellite-based system providing precise location information in real time.
- Geographic Information Systems (GIS): Computer hardware and software utilizing feature attributes and location data to create maps.
- Precision Agriculture: A farming management model responding to variability in crops, maximizing economic return while minimizing environmental impact.
- Smart Agriculture: An approach focused on climate-smart agriculture with objectives of improving productivity, enhancing adaptive capacity, and reducing greenhouse gas emissions.
- Variable Rate Application: Utilizing a control computer, locator, and actuator to adjust product quantity or type based on application maps.
- Remote Sensing: Collecting data from a distance, offering insights into crop health and enabling prompt management adjustments for enhanced crop profitability [6].

Areas of information technology in agriculture
Not only computer but information technology too plays a vital role when it comes to agriculture. Its application areas are discussed below:

- The integration of information technology in the agricultural domain is providing online services for information dissemination, education, training, monitoring, consultation, diagnosis, and transaction processing. E-commerce predominantly facilitates direct connections among local producers, traders, retailers, and suppliers. Fostering communication between researchers,

extension knowledge workers, and farmers remains crucial. Question and answer services, where experts respond to inquiries on specific subjects, enhance ICT services for block and district-level developmental officials, improving service efficiency for holistic agricultural development. Timely provision of current information to farmers on topics like agricultural practices, market dynamics, weather forecasts, input availability, and more is essential. Databases should be established detailing local resources, site-specific information systems, and expert systems [7].

- Early warning systems for diseases, pest issues, rural development programs, crop insurance, post-harvest technology, and more are vital for farmers. Facilitating online land records and registration systems is crucial. Continuous recording of information is deemed essential for long-term identification of improvements in various areas. Leveraging information technology for recording past productivity and its benefits aids in informed decision-making. Livestock rearing and milk production serve as crucial income sources in rural areas, with marketing of milk and its products being vital. Services providing farmers with information on farm business and management contribute to increased proficiency in cooperative societies through computer communication networks and advanced database technology [8].

- Tele-education initiatives for farmers, websites developed by agricultural research institutes, and the dissemination of the latest information to extension knowledge workers contribute significantly to agricultural sector development. Despite substantial potential for integrating ICT into agricultural development, only a limited number of projects have been initiated in India and globally. Intriguingly, many of these projects were spearheaded by non-governmental organizations, private entities, cooperatives, and governmental organizations outside agricultural departments [9]. This highlights the apparent lack of enthusiasm from agricultural development departments in embracing ICT in their daily operations. To formulate a comprehensive approach for agricultural development, isolated ICT projects must be thoroughly researched, and their successes should be recognized to shape guidelines for the future.

Conclusion
Agriculture stands as a varied domain where the utilization of diverse computer applications and cutting-edge technologies, such as wireless sensor technology is progressively imperative. This necessity stems from the escalating global demand for food crops, mandated by an ever-growing population. Computer applications can play a pivotal role in significantly augmenting food production sustainably, ensuring the preservation of environmental quality. Furthermore, they are poised to facilitate the upward expansion of food production in the foreseeable future. Consequently, developing nations like India must undergo an agricultural revolution by integrating computer applications to address the surging food production requirements of their expanding populations. Both the government and private sectors should be incentivized to amplify their investments in this sector, exploring innovative avenues for increased production through technological advancements.

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