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# Emerging Trends in Agriculture

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**Abstract**

This paper analyses the emerging trends in agriculture with the objectives to find out the emerging trends in agriculture, to compare the productivity from new trends with old one, to compare the environment aspects of new trends with old one, to compare the cost effectiveness of new trend with old one, to compare the safety/vulnerability of new trends with old one. The framed hypotheses are, there are many emerging trends in agriculture, productivity is more with new trends, new trends are environment friendly, new trends are not cost-effective in comparison with old technique, more vulnerability and less safety are associated with new trends. Secondary data is used for analysis. Precision Agriculture, Vertical Farming, Regenerative Agriculture, Sustainable Packaging, E-commerce in Agriculture, Developing new biological techniques, Internet of Things, Robotics in agriculture, Artificial Intelligence, Agri Drones, Big data & Analytics, Connectivity Technology, Controlled Environment Agriculture, Hydroponics are emerging trends in agriculture.

**Key words:** Precision Agriculture, Vertical Farming, Regenerative Agriculture, Sustainable Packaging,E-commerce in Agriculture **,** Robotics in agriculture, Agri Drones.

## I. Introduction:

After the food gathering activity in human civilization, agriculture became the lively hood activity. Since then it has under gone many technological changes. In the beginning of development, agriculture provides the employment to majority of workforce contributes major share to Nation's Gross Domestic Product, occupies major share in exports. Agriculture supplies raw material to agro-based industries. Agriculture provides special demand for some of the products industries like fertilizers. The development of agriculture leads to develop the service sector too. Providing food security to people and other animals entirely depends on agriculture development. Keeping the growing demand for food grains and other agriculture products, it is necessary to adopt new technology and styles in agriculture. The project analyses the emerging trend in agriculture. The project analyses the emerging trends in agriculture with the objectives to find out the emerging trends in agriculture, to compare the productivity from new trends with old one, to compare the environment aspects of new trends with old one, to compare the cost effectiveness of new trend with old one, to

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## II. Review of Literature

Aswale, Sanjay (2015) in their paper 'A Study of Recent Trends in Agriculture' concluded that there is need to incur more expenditure in agriculture and allied sectors to increase the share of agriculture in GDP of our country.

Mairton G. Da Silva, Tales M. Soares, Hans R. Gheyi, Mateus G. B. De Oliveira, Caroline C. Dos Santos (2020) in their article titled 'Hydroponic Cultivation of Coriander Using Fresh and Brackish Waters With Different Temperatures of the Nutrient Solution' mentions the importance of new trend in agriculture as follows 'Coriander plants of the cultivar Verdão are more suitable for the hydroponic system, regardless of the thermal stress of the nutrient solution and the use of brackish water'.

Naznin, Tahera & Lefsrud, M. & Gravel, Valérie & Hao, X. (2016) in their paper titled 'Different ratios of red and blue LED light effects on coriander productivity and antioxidant properties' written as follows 'The coriander plants cultured under 100% red LEDs showed a significant decrease in antioxidant properties. This research will allow for improved selection of red to blue ratios of LEDs lighting for antioxidant rich leafy vegetables or spice production'.

Oleiro Araújo, Ricardo Silva Peres, José Barata, Fernando Lidon and José Cochicho Ramalho (2021), in their paper 'Characterizing the Agriculture Landscape-Emerging Trends, Challenges and Opportunities' stresses for investment for new trends as 'Investment in technological research is imperative to stimulate the development of sustainable solutions for the agricultural sector. Advances in Internet of Things, sensors and sensor networks, robotics, artificial intelligence, big data, cloud computing, etc. foster the transition towards the Agriculture'

## III. Emerging trends in Agriculture

The emerging trends in agriculture process can be analyzed as follows:

i. **Precision Agriculture:** Precision agriculture, also known as precision farming is an approach to farming that utilizes technology to optimize various aspects of the agricultural production process. The goal is to enhance efficiency, productivity, and sustainability in the management of crops and livestock. Precision agriculture relies on data-driven decision-making, real-time monitoring, and automation to improve resource use and reduce environmental impact.

While precision agriculture has gained significant traction in modern farming practices, its adoption may vary based on factors such as the scale of the farm, available technology, and economic considerations

**ii. Vertical Farming:** Vertical farming is an innovative method of cultivating crops in vertically stacked layers or inclined surfaces, often in controlled environments such as indoor facilities, greenhouses, or even vertically inclined structures. This farming technique aims to maximize space utilization, increase crop yield, and optimize resource efficiency. Vertical farming represents an innovative solution to address the challenges of traditional agriculture, especially in densely populated urban areas. As technology continues to advance and efficiency improves, vertical farming has the potential to play a crucial role in sustainable and resilient food production systems.

The initial setup costs of vertical farming can be high, including investments in infrastructure, technology, and energy-efficient systems. Energy consumption, particularly for artificial lighting, can be a significant operational cost.

**iii. Regenerative Agriculture:**

Regenerative agriculture is an approach to farming and land management that focuses on restoring and enhancing the health of ecosystems. The goal is not only to sustain agricultural productivity but also to improve soil health, water quality, and biodiversity. This holistic approach aims to create resilient and sustainable agricultural systems.

Adopting regenerative agriculture practices can lead to various benefits, including improved soil fertility, increased resilience to climate change, reduced environmental impact and potentially higher yields over the long term. Many farmers and agricultural researchers are exploring and implementing regenerative practices as part of a broader movement toward sustainable and ecologically responsible agriculture

**iv. Sustainable Packaging:** A shift towards more eco-friendly packaging materials and practices to reduce waste in the agriculture and food industries. Sustainable packaging refers to the use of materials and design strategies that minimize the environmental impact of packaging throughout its lifecycle. The primary goal is to reduce resource consumption, minimize waste, and lower the carbon footprint associated with packaging materials. Sustainable packaging involves considering various factors, including material selection, manufacturing processes, transportation, and end-of-life disposal.

**v. Agri-Biotechnology:** Advancements in genetic engineering, such as CRISPR(Clustered Regularly Interspaced Short Palindromic Repeats) technology, to develop crops with improved traits like disease resistance and higher yields. Agricultural biotechnology, often referred to as agri-biotechnology or biotech agriculture, involves the use of scientific techniques and tools to modify living organisms, particularly plants and crops, for the purpose of improving agricultural productivity, sustainability, and overall efficiency. Biotechnology applications in agriculture can encompass a range of methods, including genetic engineering, molecular breeding, and other advanced biotechnological tools.

**vi. E-commerce in Agriculture:** The growth of online platforms for buying and selling agricultural products and services, facilitating access to a wider market. E-commerce in agriculture refers to the use of electronic

platforms and online technologies to facilitate the buying and selling of agricultural products and services. This digital transformation in agriculture has the potential to streamline processes, improve market access for farmers, enhance efficiency in the supply chain, and provide consumers with easier access to a wide range of agricultural products.

**vii. Internet of Things**

The Internet of Things (IoT) refers to the network of interconnected physical devices, vehicles, appliances, and other objects embedded with sensors, software, and network connectivity, enabling them to collect and exchange data. The goal of IoT is to create a smart, interconnected ecosystem where devices can communicate, share information, and make intelligent decisions without human intervention. In agriculture, IoT devices help farmers monitor soil conditions, crop health, and automate irrigation systems.

**viii. Robotics:** Robotics in agriculture, often referred to as agricultural robotics or agri-robotics, involves the use of robotic systems, automation, and technology in farming practices. The integration of robotics into agriculture aims to improve efficiency, productivity, and sustainability in various aspects of crop cultivation and livestock management.

**ix. Artificial Intelligence:** Artificial Intelligence (AI) is making significant contributions to the field of agriculture, enhancing various aspects of crop cultivation, livestock management, and overall farm operations. Here are some key applications of AI in agriculture:

**1. Remote Sensing** AI algorithms analyze data from satellites, drones, and other remote sensing devices to monitor crop health, detect diseases, and assess overall field conditions

**2. Image Recognition:** AI-powered image recognition systems can identify and classify crops, weeds, and pests, helping farmers make informed decisions about resource allocation and pest control.

**3. Predictive Analytics** AI algorithms analyze historical data, weather patterns, and other relevant factors to make predictions about crop yields ,optimal planting times, and potential risks.

**4. Variable Rate Technology :** AI helps optimize the use of resources such as water fertilizers, and pesticides by determining variable application rates based on specific field conditions.

**5. IoT Sensors and AI** algorithms combined with IoT sensors can monitor soil moisture levels and weather conditions to optimize irrigation schedules ensuring that crops receive the right amount of water at the right time.

**6. Machine Learning Models** AI models can be trained on large datasets of images and sensor data to accurately identify signs of diseases or infections in crops. Early detection allows for timely intervention and reduces crop losses.

**7. AI-Powered Tractors and Harvesters** Autonomous vehicles equipped with AI can perform tasks such as plowing, seeding, and harvesting costs and improving efficiency.

**8. Robotic Harvesting:** AI-enabled robots can be programmed to harvest fruits, vegetables, and other crops with precision and care.

**9. Health Monitoring:** AI systems analyze data from sensors, cameras, and other monitoring devices to detect signs of illness or distress in livestock. This allows for early intervention and improved animal welfare.

10. **Breeding Predictive Analytics** traits and health of livestock, aiding in selective breeding programs.

**11. AI in Logistics:** AI algorithms help optimize the logistics and supply chain processes, ensuring timely and efficient transportation of agricultural products from farms to markets.

**12. Predictive Analytics for Market Trends:** AI can analyze market trends and predict demand, helping farmers make informed decisions about crop selection and production levels.

**13. Decision Support Systems:** AI-powered farm management software provides insights into crop rotations, resource allocation, and overall farm planning, helping farmers make data-driven decisions. While AI brings significant benefits to agriculture, it also comes with challenges such as data privacy concerns, the need for reliable connectivity in rural areas, and the requirement for training farmers in AI technologies. Addressing these challenges can contribute to the widespread and sustainable adoption of AI in agriculture.

**x. Agri Drones:** Agricultural drones, also known as agri-drones or UAVs (Unmanned Aerial Vehicles), have become increasingly popular in modern farming practices. These drones are equipped with various sensors and cameras, and they play a crucial role in precision agriculture.

**xi. Big data & Analytics:**

Big Data analytics in agriculture involves the use of advanced data processing techniques to analyze large and complex datasets generated in farming operations.This approach enables farmers, researchers, and agricultural stakeholders to gain valuable insights, make informed decisions, and optimize various aspects of agricultural practices. Here are some ways in which Big Data analytics is applied in agriculture:

**xii. Connectivity Technology:** Connectivity technology plays a crucial role in modern agriculture, enabling farmers to access real-time data, remotely monitor equipment, and make informed decisions for optimized crop management. Here are some key connectivity technologies used in agriculture:

1. **Wireless Communication:**

- **Wi-Fi:** Wireless local area networks (Wi-Fi) are used on farms for connectivity within a limited range. They facilitate communication between devices, sensors, and machinery.

- **Bluetooth:** Bluetooth technology is used for short-range wireless communication between devices, such as sensors, smartphones, and machinery components.

2. **Cellular Networks:**

- **2G, 3G, 4G/LTE, and 5G:** Cellular networks provide widespread connectivity in rural areas. Farmers can use these networks to access the internet, receive real-time data, and remotely monitor equipment. The evolution to 5G promises faster speeds and lower latency, opening up new possibilities for applications such as autonomous farming and augmented reality.

3. **Satellite Communication:**

- **Global Navigation Satellite Systems (GNSS):** Satellite systems like GPS (Global Positioning System) and GLONASS (Global Navigation Satellite System) are used for precision agriculture. They provide accurate location data for mapping fields, guiding autonomous machinery, and optimizing routes.

4. **LPWAN (Low-Power Wide-Area Network):**

- **LoRaWAN (Long Range Wide Area Network) and NB-IoT (Narrowband IoT):** LPWAN technologies enable the deployment of low-power, long-range sensors for monitoring soil conditions, weather, and other environmental factors. These networks are energy-efficient and suitable for IoT applications in agriculture.

5. **Mesh Networks:**

- **Wireless Sensor Networks:** Mesh networks connect sensors and devices in a distributed manner, allowing them to communicate with each other. This helps in creating a network of sensors for monitoring large agricultural areas.

6. **Rural Broadband Initiatives:**

- **Fixed Wireless Access (FWA):** In some regions, fixed wireless solutions provide broadband internet access to rural areas, enabling farmers to connect to the internet for data access, weather information, and online services.

7. **IoT Platforms:**

- **Cloud-Based Platforms:** IoT platforms facilitate the collection, storage, and analysis of data from various sensors and devices. Farmers can access these platforms to monitor and manage their agricultural operations remotely.

8. **Precision Agriculture Systems:**

- **Telematics:** Telematics systems in agricultural machinery use connectivity to transmit data on equipment performance, fuel consumption, and location. This data helps farmers optimize fleet management and maintenance.

9. **Smart Farming Applications:**

- **Mobile Apps:** Mobile applications allow farmers to access agricultural data, weather forecasts, and market information from their smartphones. This connectivity enhances decision-making and facilitates communication with other stakeholders in the agricultural value chain.

10. **Blockchain Technology:**

- **Supply Chain Transparency:** Blockchain technology can be used to create transparent and traceable supply chains. This is particularly beneficial in agriculture for tracking the origin and journey of agricultural products from farm to consumer.

  Effective connectivity in agriculture enhances efficiency, enables precision farming, and improves overall productivity. As technology continues to advance, the integration of various connectivity solutions will play a pivotal role in shaping the future of smart and connected agriculture.

**xiii. Controlled Environment Agriculture:** Controlled Environment Agriculture (CEA) refers to the practice of cultivating crops within an enclosed environment where various environmental factors such as temperature, humidity, light, and nutrient levels can be precisely controlled. The goal of CEA is to create optimal conditions for plant growth and maximize yields. This approach is particularly relevant in situations where traditional outdoor agriculture may face challenges, such as extreme weather conditions, limited space, or the need for year-round production.

**xiv. Hydroponics:** The word itself is an amalgamation of two Greek words: hydro, meaning water and ponien, meaning to toil.

Hydroponics is a soilless method of cultivating plants, where nutrient-rich water solutions are used to deliver essential nutrients directly to the plant roots. In hydroponic systems, plants grow in an inert medium or are suspended in nutrient solutions, and they receive all the necessary elements for growth and development without the use of soil. This method is gaining popularity in agriculture due to its potential for increased crop yields, water efficiency, and space utilization.

Hydroponics offers a versatile and efficient method of cultivating plants, particularly in environments where traditional agriculture may face limitations. As technology and knowledge in hydroponics continue to advance, it has the potential to contribute significantly to sustainable and resource-efficient food production.

## IV. Findings and conclusion

Precision Agriculture, Vertical Farming, Regenerative Agriculture, Sustainable Packaging, E-commerce in Agriculture, Developing new biological techniques, Internet of Things, Robotics in agriculture, Artificial Intelligence, Agri Drones, Big data & Analytics, Connectivity Technology, Controlled Environment Agriculture, Hydroponics are new trends found in agriculture. Productivity is more with new trends, new trends are environment friendly,new trends are not cost-effective when we compare with old trends,more vulnerability and less safety are associated with new trends.

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