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ROLE OF DIGITAL TECHNOLOGY IN AGRICULTURE AND ALLIED SERVICES

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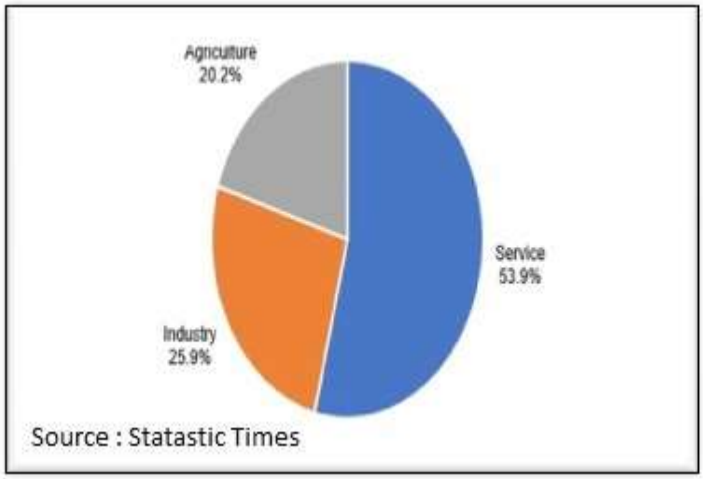
Abstract : Digital agriculture involves the application of digital technology to integrate agricultural output from the field to the consumer. Digital advancements can help developing countries overcome global poverty and hunger in rural areas more quickly. Digitalization is commonly considered as having the potential to increase agricultural output and sustainability. However, the digitalization of agricultural innovation systems is likely to have broader ramifications. Agricultural knowledge and advice networks are critical components of agricultural innovation systems that are vulnerable to digital disruption. Major technological breakthroughs include indoor vertical farming, automation and robotics, livestock technology, current greenhouse practices, precision agriculture, artificial intelligence, and block chain. Farm equipment is linked to software platforms that collect on-farm data and enable studies of soil and climate conditions in specific locations to provide farmers with advice on seed selection and more precise pesticide and fertilizer application. The abundance of knowledge about plants and animals makes farming more visible to customers. Smart farming will have an impact on agricultural production in the long run. Mobile phones have had one of the highest rates of adoption of any technology developed in the last century. Consumers and farmers will become more connected as a result of digitalization. In this study, we examine developments in agricultural knowledge get prepared to deal with potential changes in these networks and focuses at trends in agricultural information and advisory systems both internationally and in India.



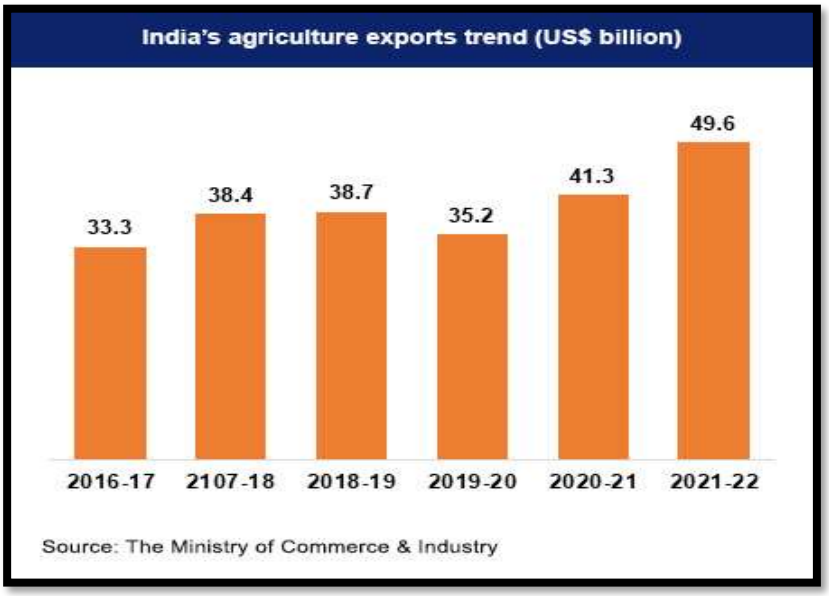
Keywords **- Digital agriculture, Mobile phones vertical farming, Digitalisation**

1.Introduction

The world is being increasingly connected as a result of digital technology. At smaller, faster, cheaper and more efficient way, mobile devices are being used. Since digitization has significant potential to benefit both producers and consumers, the drive to more widely implement Information and Communication Technology (ICT) in the agricultural field is currently gaining momentum. On the other hand, introducing technological solutions into a rural context is fraught with difficulties. Assistance is being provided to help businesses and farmers make better decisions. Farmers are receiving assistance to use more precise amounts of water and fertilizer and to maintain greater operational control. Many operations, including planning farming activities, budgeting, reporting, and monitoring numerous chores and performances, are made simpler by digital technologies. Farm equipment, animal handling facilities, agronomy, communication, and other areas all use digital technology. Agriculture is at the start of a new revolution, one in which data and connectivity will play a key role.

Artificial intelligence, analytics, connected sensors, and other advanced technologies have the potential to increase yields, enhance the efficiency of water and other inputs. These can help for building sustainability and resilience across crop cultivation and animal husbandry. Digital farming technologies include the application of sensors, automation, and robots in production systems.

2. Overview of Agriculture in India



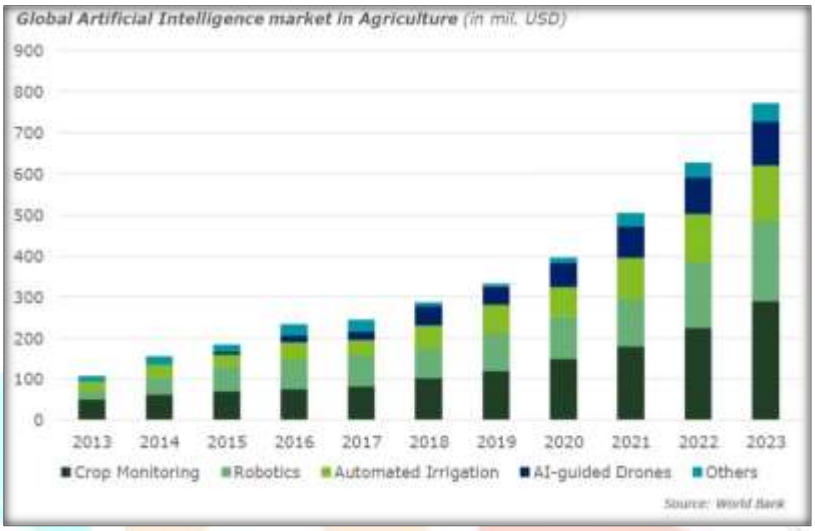
The expanding economy of India is significantly influenced by agriculture. With around 54.6% of the total workforce involved in agriculture and allied sector activities, the sector contributes to 17.8% of the country's gross value added (GVA). During 2021-22, the country recorded US$ 50.2 billion in total agriculture exports with a 20% increase from US$ 41.3 billion in 2020-21. It is projected that the Indian agriculture sector will grow by 3.5% in FY23. With the use of conventional farming methods, there's comparatively less improvement in efficiency and agricultural yields which resulted in lower productivity. Due to this concern, the government initiated the fourth wave of revolution in the agricultural sector to introduce technological advancement in these activities to improve yields and promote the involvement of the population in this sector. The idea of revolution in agriculture involves the use of the Internet of Things (IoT), big data, artificial intelligence, and robotics to accelerate and improve the efficiency of activities throughout the entire production chain. It has the potential to transform the conventional farming industry. Traditional agricultural methods regulate crop irrigation and evenly distribute the application of pesticides and fertilizers across the entire area. In contrast, the farmers will need to be more data-driven and targeted when it comes to farming. Future farms will be more productive owing to the employment of robotics, temperature and moisture sensors, aerial photos, and GPS technology. These cutting-edge methods will improve farm profitability, efficiency, safety, and environmental friendliness. They are together referred to as advanced or high-tech precision farming. Notably, the government is looking into measures to increase farmers' profitability and agricultural efficiency as well as ways to help them quadruple their incomes by 2022 when compared to the base year of 2015–16.Farms will be able to be more productive, efficient, safe, and environmentally sustainable owing to this cutting-edge equipment, robotic systems, and precision agriculture. Various factors such as data analysis matrix and technological advancement in the existing agricultural machinery contribute to the production of food grains for consumption and commercial needs. The production of commercial food grain supports the economy and improves the GDP.As a result, the future development of Indian agriculture appears to be increasing with an upward graph, supported by both government initiatives and technical improvements.

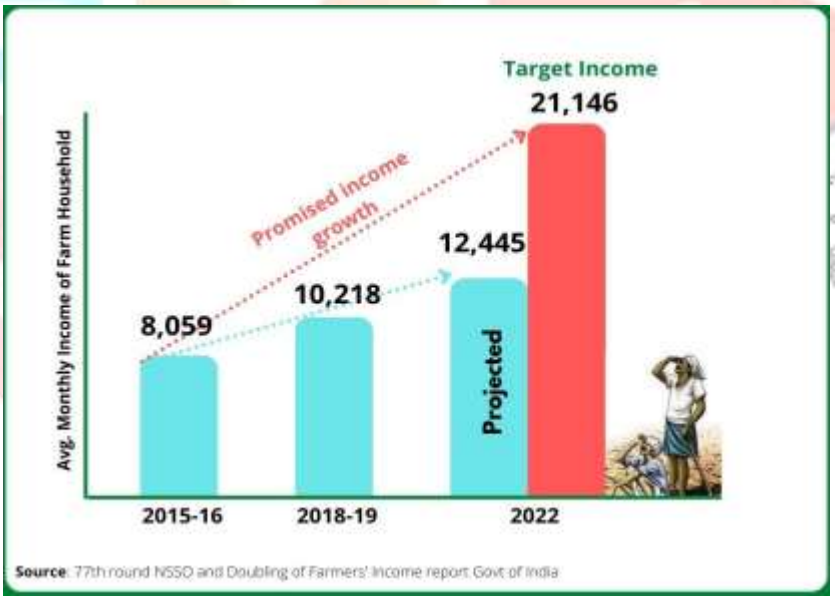
3. Prospects of Indian Agriculture

India is one of the top exporters of agricultural goods worldwide. The nation's overall agricultural exports in 2021–22 totaled US$ 49.6 billion, a 20% rise from US$ 41.3 billion in 2020–21. India's agriculture sector primarily exports agri & allied products, marine products, plantation, and textile & allied products. Agri & allied products exports were valued at US$ 37.3 billion, recording a growth of 17% over 2020-21.The continuous technological innovation in the Indian agriculture sector plays a critical role in the growth and development of the Indian agriculture system. Promoting equitable and sustainable growth will be essential for ensuring agricultural production, creating jobs, and eliminating poverty. Constraints include diminishing and degraded land and water resources, drought, flooding, and global warming generating unpredictable weather patterns that present a significant barrier for India's agriculture to grow sustainably and profitably. Robotics, temperature and moisture sensors, aerial photographs, and GPS technology appear to be highly developed technologies that will be used in agriculture in the future.

4. Recent Trends in Agriculture

India's agriculture primarily depends on nature, but the unpredictable nature of farming is being exacerbated by climate change and global warming. The development of digital technology in India was prompted by the requirement to adopt contemporary technologies to boost productivity and profitability. Over the years, India's agricultural landscape has undergone substantial transformation, and numerous new technologies have been created. Several new-age farmers are using soil mapping software as well to determine the optimum level of fertilizers used in the farms.





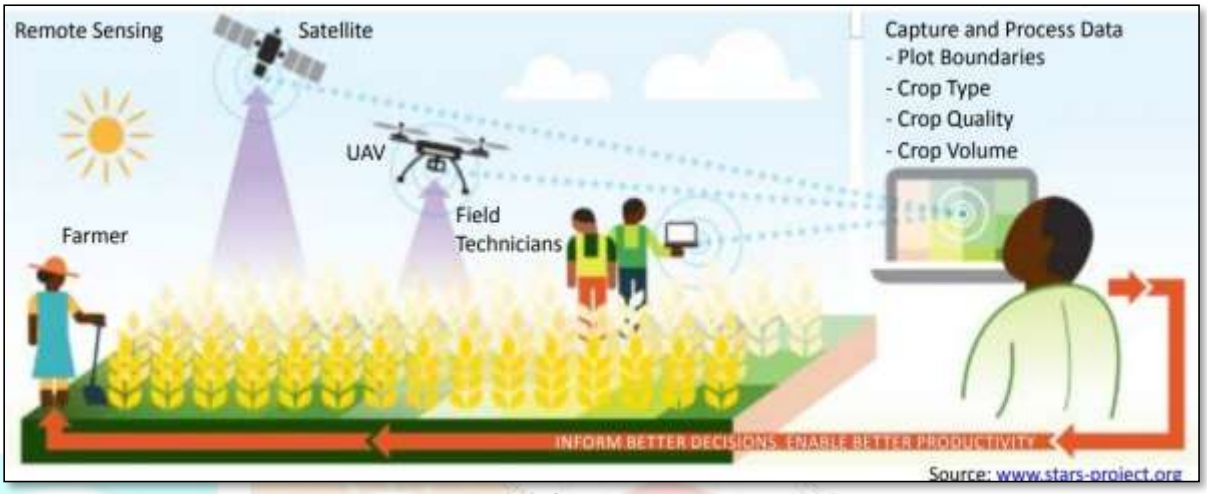
The global market for Artificial Inteligence(AI) in Agriculture is valued at 240 million USD in 2017 and is expected to reach 790 million USD by the end of 2023, growing at a CAGR of 21.8%.The market for crop monitoring accounted for more than 35% of the global revenue in 2016and during the forecast period AI-guided drone is expected to be the fastest growing solution. With the help of precision agriculture, these technologies enable farmers to increase yields while utilizing the fewest resources possible and minimizing their total environmental effect.

These emerging technologies in farming and agriculture pave the way for more opportunities. The agro-tech start-ups and traditional farmers are also using the latest solutions and trends to improve production in the food value chain. It includes the adoption of new technologies such as cloud-based solutions and other relevant advanced agricultural management techniques to increase farmer efficiency and produce more crops. Increased production, increased investment, diversification of the sector, use of modern techniques, development of horticulture and floriculture, rising export volume, and growth of the food processing industry are emerging trends in the agricultural sector that are quite prominent in the post-liberalization era.

5. Digital Agriculture-Requirement of the present time

Remote sensing data on soil conditions can help farmers manage their crop (5). Entrepreneurs in Africa are interested in how farmers operate and how they may increase output.The cost and accessibility of cloud computing, computer systems, connectivity, open-source software, and other digital technologies has lowered the entrance barrier

into farming technology. Mobile phones lower the cost of information and improve farmers' access to markets and financial assistance (6). Farmers, investors and entrepreneurs can use digital technology to improve efficiency of food production and consumption in Africa. From precision farming to a more efficient food supply chain, technology has the potential to bring major economic, social and environmental benefits (7).Digital agriculture involves the application of digital technology to integrate agricultural production from the paddock to the costumer. Agricultural industries can benefit from these technologies by more tools and information to make better decisions and increase productivity (8). In rural areas of developing countries where majority of people rely on agriculture for their living, digital technology can assist for overcoming global poverty and hunger more quickly. In digital agriculture, farmers use mobile phones and other technologies that could revolutionize for the communities to secure and improve their livelihoods (9).It is required more productive, efficient, sustainable, inclusive, transparent and resilient food systems for achieving the UN Sustainable Development Goal of a 'world with zero hunger' by 2030 (10).



Digital skills and people who are capable of using digital devices, comprehending outputs and developing programmers and applications are in high demand as a result of digitalization. Basic literacy, numeracy, data handling and communication skills are required. Education must improve quickly in areas where skills are low (11). Indoor vertical farming, automation and robotics, livestock technology, modern greenhouse practices, precision agriculture and artificial intelligence and block chain have been all major technological advancements in the space.

Indoor vertical farming has the potential to increase crop yields, overcome land constraints and shorten supply chain distances. Vertical farms use up to 70% less water than traditional farms (12). Mobile phones are at the top of the list of digital technologies revolutionising agriculture. Compared to other recent technologies, they have the highest adoption rates. Two thirds of the world's population, or almost 5.2 billion people, were active mobile phone users as of 2019. Mobile internet is also on the increase, with 49% of the global population using internet services on a mobile device. Only 9% of the world's population lives beyond the service area of a mobile network. Mobile phones have transformed the life of many rural people, particularly small-scale farmers. Farmers may access solutions, such as advisory services that offer ideas on raising outputs, keeping livestock healthy and up-to-date weather information even if they do not have access to mobile internet. Farmers may even access wider choice of high-tech solutions via smart phone applications which can diagnose ailing crops and recommend remedies for many types of pests, diseases and nutrient deficiencies (13)

Precision agriculture technologies are transforming the face of modern farming. Digital advancements such as wireless communication, data analytics, and data-driven genome editing, are rapidly being applied in agriculture as they provide more accuracy in decision making and practice. Farm equipment is connected to software platforms that track on-farm data and enable analysis of soil and climate conditions. Agricultural genome makes use of big data generated from computer assisted genomic mapping to determine edits to the DNA of living organisms which promise a more accurate way to modify a plant's genetic code to express new traits for improving crop production (14). Consumers and farmers will be closer together due to digitalisation. Consumers can learn about plants and animals that will make farming more transparent. In the long run smart farming will affect agricultural production (15).AI currently helps farmers increase yield by assisting them in choosing better crops, hybrid seeds, and resource-efficient farming techniques. It is also utilised to improve farming productivity and accuracy to assist farmers in creating seasonal forecasting models.

6. Digitalisation of Indian Agriculture

The report on doubling farmers' income by 2022 advocates for the adoption of digital technologies in agricultural practices it will help in boosting farmers' income. To achieve the vision of the Self-Reliant India Movement and Sustainable Development Goals (SDGs), the transformation of traditional agriculture into digital agriculture is imperative. Farmers are the primary stakeholders in the food production and supply chain as producers, so it will be difficult to achieve and sustain food security without ensuring farmers' well-being and satisfaction. Policymakers must concentrate on the empowerment of the farming community by, for example, establishing a Digital Agriculture Mission (2021-2025) and consultation paper on Digital Agriculture Ecosystem.Digitalisation has the potential to make agriculture policy more effective in minimising the undesired impacts and maximising the benefits of farming. The digital agricultural policy replaces the technologies used in traditional farm policy. It

offers newer alternatives for an agricultural policy: real-time databased or more evidence-based policy interventions for effectively addressing the challenges in the agriculture sector. Thus digitalisation is shifting the agriculture policy from direct intervention to information-based governance, which will increase the policy outcomes and ultimately secure the trust of farming communities and will maximise their satisfaction (Ehlers et al, 2021).

7. Some of the recent trends in agricultural technology:

Agricultural Drone Technology-

Drones are frequently utilized in healthcare delivery, disaster relief, and agriculture to enhance crop growth, maintenance, and cultivation techniques. These aerial transporters, for instance, are employed to monitor crop conditions and carry out improved fertilization plans for higher harvests. Hovering robots are even available to farmers, who may use them to survey vast regions and collect data to improve their understanding of their fields. Drone use in agriculture has made it possible to remotely monitor animals and crops more often and affordably. Additionally, it aids in analyzing field conditions and selecting the proper fertilizers, nutrients, and pesticides.

Diversification of Agriculture-

The agricultural sector produces crops such as fruits, vegetables, spices, cashews, areca nuts, coconuts, and floral items such as flowers, orchids, and so on. With the rising demand for these items, there is enormous opportunity for manufacturing and commerce. This demonstrates how the agricultural industry is being changed into a dynamic and commercial sector by moving the mix of conventional agricultural goods toward better quality items, with a great potential for increasing production rates.Changes in technology or consumer demand, commerce or government policy, transportation, irrigation, and other infrastructural innovations all contribute to agricultural diversification.

Increasing Trend in Horticulture Production-

The availability of diverse physiographic, climatic, and soil characteristics enables India to grow various horticulture crops. It includes fruits, vegetables, spices, cashew, coconut, cocoa, areca etc. The total horticulture production in FY22 is estimated at 342.333 million tonnes which is an increase of about 7.03 million tonnes (2.10% increase) from 2020-21.

8. Development of Agriculture in Backward Areas-

In the post-green revolution era, new agricultural techniques, research, and technology were largely focused on growing particular food grains, such as wheat and rice. However, as a result of the wave of liberalization and rising demand for agricultural exports, numerous new agricultural businesses have become favorable and profitable.Dryland farming has been established in some agriculturally backward locations where there is no irrigation infrastructure and access to fewer resources. Other enterprises such as horticulture, floriculture, animal husbandry, fishing, and so on were also promoted. Various sophisticated procedures have been introduced in backward areas to help with development.

Ariel Imaging

Ariel imaging use geographic information system (GIS) technology to assess the feasibility of irrigation projects and their influence on land degradation, erosion, and drainage. This technology's graphics enable analysis of a single plant's leaf. To safeguard crops from environmental risks, these visualizations are actively employed to identify pests and illnesses. It primarily assists farmers in monitoring agricultural soil conditions and is especially valuable during the summer months when water is scarce.

Hydroponics and Vertical Farming

The goal of hydroponic farming is to produce crops with greater yields, texture, and flavor while using less water. Hydroponically grown plants do not require substantial root systems, which enables them to devote more energy to the creation of leaves and fruits. These plants develop more quickly and have greater defenses against pests and other illnesses as a result of indoor culture. In terms of sustainability, vertical farming enables farms to be situated close to or inside of densely populated regions, reducing the need for transportation and any harmful emissions. Growing crops in urban settings is possible because to vertical farming, which also helps to readily make fresh food available. Compared to traditional farming practices, this farming dramatically decreases the amount of land space needed to cultivate crops.IoT in Agriculture – IoT assists agriculture by putting numerous sensors in farming facilities. These sensors are used to keep an eye on things like crop health, temperature, humidity, light, and soil moisture. The following are some of the key IoT applications in agriculture:The gathering of data to analyze the operation of the farm is facilitated by a variety of farm sensors, including autonomous cars, wearables, button cameras, robots, control systems, etc.use of drones for field analysis, irrigation, monitoring, and crop health evaluation from the air and on the ground.using techniques to anticipate weather, soil conditions, humidity, and other natural disasters.

9. Initiatives

The Digital India Programme, which intends to digitally overhaul India's public service sector, was introduced by the Indian government in 2015. With a 14% GDP share, agriculture, which is the largest employment sector, is crucial to this digital initiative.The government has launched a number of efforts to facilitate India's agriculture sector's potential digitization. It focuses on supporting agri-tech companies who are trying to increase production.The architecture for the federated database of farmers will be established by the India Digital Ecosystem of Agriculture (IDEA) framework, which has been finalized by the government. By combining the digitalized land records with the publicly accessible data that already

exists in various systems, this database is being created. The IDEA would act as a base for developing creative, agri-focused solutions that make use of cutting-edge technology to significantly improve India's agricultural eco-system. This Ecosystem will assist the government in making plans that would increase farmer income and boost the effectiveness of the agricultural industry.The Krishi Yantra App was developed by the Central Institute of Agricultural Engineering, Bhopal (ICAR-CIAE) of the Indian Council of Agricultural Research (ICAR) to facilitate agricultural engineering research, operations, and technology transfer. On its website, ICAR-CIAE has established a web portal accessible to ensure that firms select the appropriate mechanization technology. This makes it easier for existing and future business owners to select equipment and payment methods. The platform also provides a user and expert engagement option.The ICAR-CIAE created the Farm Safety app, which offers information on safety precautions and safety gadgets to prevent mishaps when using various agricultural machines.Decision-makers can offer design requirements with the use of the Water Balance Simulation Model for Roof Water Harvesting smartphone app. It specifies instances in which installing a roof-mounted water harvesting system might lead to water savings and water security.India has seen a significant improvement in yields and crop diversity as a result of mechanization and information dissemination initiatives. However, as a result of the population growth and increased wealth, consumption is rising.

The Indian Government has launched a number of initiatives. IIT Kharagpur is educating the farming community through training and putting on outreach events (16).Researchers at MIT have found a promising method for protecting seeds from water shortage stress during their crucial germination phase and additionally providing the plants with more nutrition at the same time (17). Researchers at the Singapore-MIT Alliance for Research and Technology (SMART) and Temasek Life Sciences Laboratory (TLL) have designed a portable optical sensor which can reveal whether a plant is under stress. This device helps as a new tool for early analysis and real time monitoring of plant health in field conditions (18).

10. Conclusion

Agriculture is an important sector of the country. It is one of the market-driven industries that employ a large segment of the country's population.It's is made up of a series of complex interconnected processes. It should be organised into efficient stages to ensure a good yield. A triangle formed by the farmer, technology and the service and consulting concept will determine the success of a given product. Agriculture like other areas in the economy will be digitised in the future. Government should spend time and financial resources for socialising the digitisation benefits. Inadequate connectivity in rural areas, high service charges, and a lack of basic computer literacy and understanding are obstacles for the quick development of e-agriculture. Physical infrastructure, power, broadband and transportation all require substantial investment.The future of Indian agriculture seems bright and promising with the advent of new technologies. The government has increased its focus on the sector, implementing various policies and initiatives to boost productivity and growth. India's vast and diverse agricultural landscape, coupled with advancements in technology, provides immense opportunities for farmers to harness their potential and increase yield. In addition, start-ups in the agricultural sector are working towards providing innovative solutions to farmers in terms of supporting them with better productivity, measuring tools and other data-driven strategies.

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