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Study on Efficacious Agricultural Technologies

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Abstract:- For the majority people in India, the agriculture industry is their main source of income. India's policy discussions continue to center on the industry's low and stagnating income. The global market and the agriculture industry are becoming more intertwined, and the sector is also being affected more by environmental, food safety and quality, and animal welfare standards. To fulfil the rising need for food, to remain competitive globally, and to create high- quality agricultural goods, it must overcome new obstacles. In the context of ongoing agricultural policy change, it must also fulfil sustainability goals. Adoption of more advanced agricultural technology is one of the most popular strategies to increase farmers' revenue. This report provides information on India's present agricultural technology situation. Technology must be used effectively in agriculture to increase output and worker employability. Understanding how to employ technology in the agriculture industry effectively is the major goal of this study article. Several different kinds of technology are used to increase productivity. The main factors affecting the adoption of technologies, types of technologies, technologies used in the agricultural sector, advanced agricultural technologies currently in use, areas of information technology, and the function of information technology in managing agricultural education have all been taken into consideration. The agricultural industry has to get familiar with new technologies like biotechnology, nanotechnology, high-tech protected farming, and contemporary irrigation systems to increase productivity if it is to expand and develop effectively.

Keywords:- *Information and Communication Technologies (ICT), Biotechnology, Smart Material, Information Technology, Nanotechnology, Variable rate technology (VRT).*

I. INTRODUCTION

India, which has 1.3 billion inhabitants, is second in theworld in terms of agricultural output. In 2021, the sector that included agriculture, forestry, and fisheries represented for 16.4% of the total gross value added (GVA). In contrast, the sector provides more than 50% of the inhabitants of the nation with their main source of support [1,2]. The issue of low and stagnant income in all of these areas continues to dominate India's policydiscussions. The majority of the poor in the nation are concentrated in these industries. According to recent estimates, there are 220 million impoverished people inIndia. Using more advanced agricultural technology is one of the most common strategies to increase farmers'revenue [1].

People in rural regions are thought to work mostly in agriculture. Modern and new methods must be applied in the agriculture industry in order to feed the growing population. In order to push yield frontiers forward, utilize inputs creatively, and diversify towards more sustainable and high-value cropping patterns, new technologies are needed. They are all knowledge intensive technologies that need both capable farmers and an effective research and extension infrastructure [3]. It also calls for a reinforced interface, where the focus is on a shared interchange of information that benefits everyone. The motivation for using agriculturaltechnology is said to be making efficient use of resources.

A number of agricultural revolutions have boosted the industry. They include the ICT Revolution, the Green Revolution, the Evergreen Revolution, the Blue Revolution, the White Revolution, the Yellow Revolution, and the Biotechnology Revolution. Using technology is crucial for increasing production, and what is needed is the expansion of these established systems. The most important factor in agricultural expansion is considered to be infrastructure-assisted agriculture extension. The private sector's involvement would aid in this industry's quick adoption of newtechnology [4].

II. IMPLEMENTATION OF TECHNOLOGY

There are several obstacles and problems that need to be handled in order to effectively adopt ICT in rural areas and the agricultural industry. Access, quality, and cost are the three main issues in rural areas [5]. Inadequate infrastructure, including that for communication, transportation, water, and energy, is a common problem in rural regions. Almost all rural populations have poor literacy rates. In comparison to metropolitan regions, mobile connection and service quality in rural areas are quite low. The largest obstacleto providing ICT services in rural regions is a lack of energy. The majority of amenities and services areoffered in English, which is neither helpful or appropriate for rural communities.

The potential use of ICT in rural development might put an end to the isolation of those who are poor, cut off from metropolitan services, and unable to fully engage in the global economy. Several of the development- related problems ought to be handled together. By concentrating on three overlapping areas demand, supply, and environment sustainable growth may be attained. The more we learn about rural communities, the better we can comprehend them. One may design with the needs of the user in mind if they are aware of the end user. To address a gap that currently exists, innovations are needed to identify the behaviors or procedures that are simpler to adopt [6]. The agricultural development strategy is shown in Figure 1.

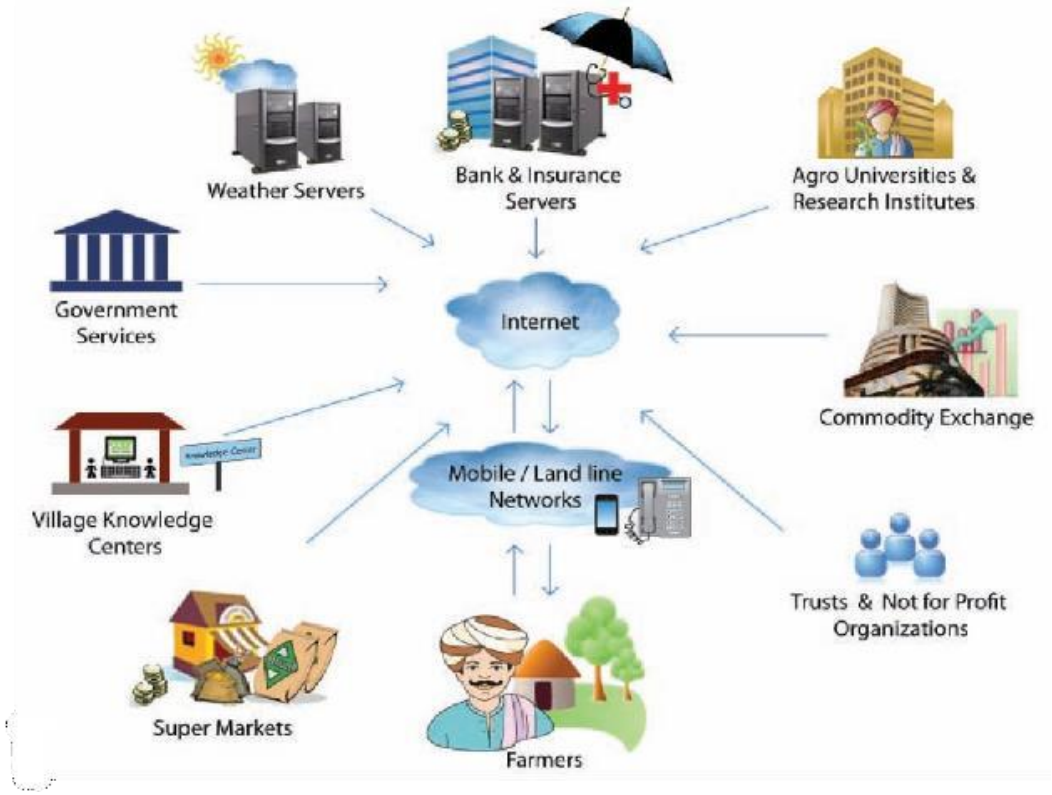

Fig. 1: Strategy for Agricultural Development

Technology adoption entails risk and trade-offs. It is crucial for the technologies to support an economically effective agricultural sector, the financial viability of the farmers, and improved environmental performance in order to create sustainability. Technology is developing quickly, and information on the costs and advantages of implementing new technology in agriculture is sometimes insufficient. So, decisions on the adoption of technology are made in an environment of ambiguity with a significant degree of trial and error in its application, and the rate and extent of adoption vary dramatically across farmers [7]. The organization of the farms and the number of farmers who are able tosecure their financial situations in the future may be significantly impacted by this.

The implementation of sustainable farm technologies is being aided by research and development initiatives, the movement towards better farmer education and training, the shift in the focus of guidance, quick and affordable ways of disseminating and exchanging information, the availability of financial resources, pressure from consumers, non-governmental organizations, the media, and the general public. To adopt technology and farming techniques, farmers need to be properly educated and informed [8]. When farmers are certain that their investments will be profitable, they will invest. Agricultural policy may alter the costs that farmers must pay for inputs and outputs, which may affect their investment choices and result in unsustainable agricultural methods.

III. TECHNOLOGY IN AGRICULTURE

Using technology in the agricultural industry is primarily intended to boost productivity and ensure thatthere is enough food for everyone. The following technologies have been mentioned:

- **Protected Cultivation:** Production of horticultural crops has increased both qualitatively and quantitatively in protected cultivation, also known as greenhouse culture. In India, there are now 25,000 hectares of land under protected agriculture. Although there are roughly 2000 hectares of greenhouses where vegetables are grown. Land holding restrictions, fast urbanization, declining agricultural output, declining biodiversity, and an ever-increasing population have all contributed to an increase in the need for food, particularly vegetables, which have undergone repeated and protected cultivation [9]. These elements have provided a fresh perspective on how to generate more in a little space. Rainwater collection may also be done in polyhouses. A 175 square meter polyhouse has an erratic yearly demand of around 52,000 liters. The semi- annual need for a crop of six months length is 26,000 liters of water. The amount of rainwater pouring on the poly-roof houses in an area with an average yearly rainfall of 400 mm is in the neighborhood of 70,000 liters. 56,000 liters of rainwater may be collected on theassumption that collection productivity is 80%, which is more than the required amount annually [8].
- **Nanotechnology:** There are several ways that nanotechnology may be applied to agriculture. With carbon nanotube enhanced seed emergence, effective weed control, delivery of agricultural chemicals, field

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sensing systems to monitor crop conditions and environmental stresses, and enhancement of plant traits against environmental pressures and diseases, it can aidin promoting soil fertility and balanced crop nutrition. Significant prospects for the creation of novel goods and uses for agriculture, water treatment, food production, processing, preservation, and packaging aremade possible by nanotechnology. The food business, consumers, and farmers all stand to gain from its use. In certain nations, people may purchase food, health food items, and food packaging materials made using nanotechnology [10]. Other goods and uses are now in the research and development stage. The packaging of food has a tremendous deal of potential to be transformed by nanotechnology. Once functionalized, nanoparticles like titanium dioxide, zinc oxide, and magnesium oxide or a mixture of them can be effective in killing microorganisms. These particles are also less costly and safer to utilize than metal-based nanoparticles.

- **Biotechnology:** Using biotechnological technologies in agriculture may increase cropproductivity and make them more resilient to biotic andabiotic issues. With the rising demand for food, the effects of climate change, and the shortage of both land and water, this might relieve the situation and improve food supplies. In 2012, 170 million hectares, or around 12 percent of the world's arable land, were planted with genetically modified crops such soybean, maize, cotton, and canola by more than 17 million farmers. Nevertheless, the majority of these crops were not cultivated primarily for direct consumption. In India, the first commercialization of genetically modified cotton and biotechnology cotton occurred in 2002, and by 2012, over seven million farmers had adopted this technique over 10.8 million acres, or 93 percent of the nation's total cotton acreage [10]. The farmers' profitability has grown thanks to biotechnology cotton, which has also greatly decreased the usage of chemical pesticides in this crop. Biotechnology has helped Indian cotton producers experience a 15–20% reduction in food insecurity [9].
- **Autopilot Tractors:** Tractors, combines, sprayers, and other agricultural equipment may accurately navigate themselves using GPS. After inputting the width of the pathway that a particular piece of equipment will cover into the on-board computer system, the user will drive a short distance while positioning A and B points to form a line. With a trackto follow, the GPS system extrapolates that line into parallel lines that are spaced apart by the width of the tool being used. Curved lines can also be tracked by these systems. Due to the tractor system's connection to the steering, staying on the track is made easier [11].
- **Technology on Variable rate and Swath control:** Swath control and variable rate technologies are building on GPS technology (VRT). The point at which direction starts to pay off significantly is at this point. The width of the swath a particular piece of machinerycuts through the field is at the farmer's control [15]. Theoperation of swath control is illustrated at this point. Less use of inputs like seeds, fertilizer, insecticides, pesticides, herbicides, etc. results in cost savings. Because fields are asymmetrical in terms of size and form, there will always be some degree of overlap [11].
- **Modification in Weather:** Weather modification is the deliberate alteration or manipulation of the environment with the primary goal of changing the weather. Cloud surveillance is a well-known technology that may be used to improve the likelihood of rain or snow and so control the local water supply. Climate engineering, which involves actively interfering with the climate system, will be possible in the far future because to improvements. The removal of carbon dioxide and the control of solar radiation are thetwo major technologies used to combat global warming[4].
- **Telematics:** This technology allows for communication with other equipment, dealers for other equipment, and even farmers. Telematics allows accessto the tractor's on-board diagnostic system when one has to stop work because of a problem with the machinery. The equipment might be fixed directly fromthe dealer depending on the issue. The farmers are able to return to work in this manner and also save time by forgoing a visit to the dealer. Farmers may monitor the status of their field equipment, fuel usage, operation times, and much more. Also, this technology helps tractors communicate with one another [11].
- **Livestock:** To a significant extent, livestock has helped to increase production in the agricultural sector. As a result, it's critical to attend to their requirements. The development of livestock collars is assisting people in managing their herds. The collars' sensors convey information to a rancher's smart phone, letting himknow where his cattle may be or whether they may be having a problem [12]. The folks may keep track of where and how their herds are situated. It functions as asort of herd telematics. It's crucial to maintain track of animals when farmers and agricultural workers are working since livestock rearing is a significant activity in rural regions.
- **Smart Materials:** The phrase "smart materials" refers to a group of substances that can adapt to changes in pressure, temperature, humidity, acidity, and electric and magnetic fields, among other environmental factors. Piezoelectric materials, also known as piezo crystals, shape memory metal, electric and magnetic- rheological (ER/MR) liquids, conductive polymers, color-changing materials, and light-emitting materials are a few examples of these materials. Smart materials have been utilized successfully to remove hazardous compounds, increase functional performance, change packaging, and other things [14].
- **Documentation of Field:** With the help of on- board monitors and GPS systems, it is getting easier and more precise every year to record yields, application rates, and tillage techniques. In reality, farmers are becoming more familiar with the ideas, and they have access to important and valuable data, so it might be difficult to know how to put them into practice effectively [9]. Harvesting machinery assesses yield and moisture as it passes through the field, linking it toGPS coordinates as it does so. The finished field map isprinted, and they are frequently referred to as heat maps.

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- **Production of crops:** There are a lot of factors thatneed to be taken into account in order to increase crop output. The farmers must make sure the seeds, tools, and other materials used are of high quality, the duties and functions are carried out correctly, and they have the necessary knowledge and skills. In order to use technology properly, they must have the necessary knowledge and awareness. In order to generate a climate that is favorable for crops, a technology called weather manipulation is required. Crop output rises when the ideal climate is produced for them. Long-term use is necessary for this technology to prosper [10].
- **Renewable Energy:** The creation of electrical electricity is the primary usage of renewable energy sources like wind and solar energy. In order to switch tothis source of energy, many current fossil fuel-based activities, such heating and quick motions, must be electrified. If there are no more fossil fuels, bio fuels could be a part of the answer. The use of renewable energy is crucial in the agriculture industry. There are several explanations for why the agriculture sector has been crucial to the creation of renewable energy [11].
- **Bio-refinery and bio fuels:** Bio-refinery tries to efficiently process biomass for maximum component use and little waste. There is no more farmland needed for the full exploitation of biomass. To achieve optimalusage and prevent rivalry between food, fodder, and fuels, it is also possible to interchange the remaining flows of biomass through different value chains. Fuels produced from biomass are referred to collectively as bio fuels. Bio fuel cannot often be used in place of gasoline or diesel without modifying the engine. Emissions of carbon dioxide are reduced by 50% with first-generation bio fuels and by 90% with second-generation bio fuels [11].

IV. INFORMATION TECHNOLOGY SECTOR

Online services for information, education and training, monitoring and consulting, diagnostic and monitoring, and transaction and processing are all made possible by the use of information technology in the agricultural industry. Direct links between regional producers, traders, retailers, and suppliers are the main purpose of e-commerce. Communication between researchers, extension knowledge specialists, and farmers must be facilitated. To increase the effectiveness of providing services for full agricultural development, development authorities at the block and district levels might use question and answer services where specialists respond to queries on a certain subject's ICT services. Farmers need to be informed as soon as possible on topics including bundles of practices, market data, weather forecasts, input supplies, loan availability, and other related topics.

The specifics of the villagers' resources, site-specific information systems, expert systems, and other information should be recorded in databases [13]. giving out information on initiatives for rural development, crop insurance, post-harvest technologies, and early warning systems for illnesses and pest issues. Facilitating land records and online registration systems is essential for farmers. Even over the long term, keeping track of information is seen to be important for identifying the advancements made in many sectors. People can learn about the advantages of information technology by recording information about productivity in the past and then capturing information using that technology. In rural communities, raising cattle and producing milk and milk products are seen asessential to creating a source of income. The marketing of milk and milk products is a human activity. Services that inform farmers on managing and operating their farms. Cooperative societies' efficiency and productivity have increased thanks to modern database technology and computer communication networks [13].

The growth of the agricultural industry has been significantly aided by tele education for farmers, websites developed by agricultural research organizations, making the most recent material available to extension knowledge workers and getting their comments [14]. Only a few initiatives have been started in India despite the huge potential to integrate ICT for agricultural growth. It is encouraging to note that a large number of these initiatives were initiated by non-governmental groups, commercial organizations, cooperative bodies, and state agencies other than agricultural departments [15]. This demonstrates the lack of interest agricultural development departments have in integrating Technology into their routine tasks. It is necessary to do study on isolated ICT initiatives and recognize the familiarities developed to set guidelines for the future in order to define an approach for full agricultural growth.

V. CONCLUSION

With the primary goal of satisfying people's needs for food, the relevance of technological use in agriculture has been acknowledged. Although India's agriculture has improved, its principal horticultural and agricultural crops are less productive than those in other nations.

The use of technology still has shortcomings. Food grain, fruit, and vegetable yields per acre in the nation are far below average worldwide. Even the most productive states in India fall short of the worldwide average. Similar to this, by taking into account the seeds, soil health, pest control, crop-saving irrigation techniques, and post-harvest technologies, the productivity of pulses and oil seeds may be boosted.

To fulfil the demands of a growing population, food production would need to be significantly boosted. Many individuals in rural areas live in deplorable circumstances and are socially and economicallybackward. As agriculture is the main activity of people in rural regions, using technology and cutting-edge, inventive techniques and approaches would be beneficial for enhancing people's quality of life and reducing the effects of poverty. The agricultural industry employs a wide range of people and technologies, and farming methods require expertise and information on how to use them effectively.

As an agricultural enthusiast, I have proposed the development of a solar-powered agricultural robot that will have several innovative features to revolutionize the farming industry. This robot will operate autonomously, reducing the reliance on human labour and increasing efficiency in various agricultural operations such as seed sowing, weeds cutting, smart irrigation, ploughing of field, pesticide spray, drainmaking and levelling of field. One of the primary features of my proposed solar-powered agricultural robot is the use of artificial intelligence (AI) to enhance its functionality. The robot will be equipped with soil moisture sensors, temperature and humidity sensor that will optimize irrigation.

The smart irrigation feature allows farmers to optimizewater usage and reduce water wastage, resulting in better conservation of this precious resource. The temperature and humidity sensors allow farmers to monitor environmental conditions and make informed decisions about planting, watering, and harvesting crops. The robot's ability to plough, weed, and level thefield will improve soil quality, leading to better crop yields, reduced erosion, and improved plant health. Thepesticide spray feature will help farmers target specificareas that require treatment, reducing the use of chemicals and minimizing environmental impact. Overall, my proposed work on a solar-poweredagricultural robot with its multiple features is an innovative solution that has the potential to transform farming practices. It will help farmers increase efficiency, save time and resources, while also contributing to the sustainable and responsible use of natural resources.

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