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Application Of Drone Technology In Agriculture

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Abstract: Drone technology has emerged as a revolutionary tool in modern agriculture, offering a range of applications that enhance productivity, sustainability, and efficiency. This project explores the utilization of drones in precision agriculture, focusing on key areas such as crop monitoring, soil and field analysis, irrigation management, and pesticide application. By leveraging aerial imagery and data analytics, drones enable farmers to assess crop health, detect issues such as pest infestations or nutrient deficiencies, and optimize resource use. The integration of drones with other technologies, such as Geographic Information Systems (GIS) and Artificial Intelligence (AI), further improves decision-making processes in real-time, reducing environmental impact and operational costs. This study aims to demonstrate the benefits and challenges associated with the adoption of drone technology in agriculture, highlighting its potential to transform farming practices and contribute to global food security.

KEYWORDS: Drone Technology in Agriculture, Modern Agriculture, Environmental Benefits, Unmanned Aircraft Vehicle, Precision Agriculture.

I. INTRODUCTION

Drone usage is expanding rapidly across nearly all industries, but it is most common in the agricultural field. Based on certain projections, the agricultural drone market is anticipated to expand from a 2019 value of $1.2 billion (USD) to a $4.8 billion industry by 2024. In the upcoming years, there will be an increase in the usage of drones for security and reconnaissance on both large and small farms. Drone data collection on farms is a component of "precision agriculture," a technology that is commonly employed to improve agronomic decision-making. Drones are already a crucial component of large-scale precision farming operations in several places. Farmers can more effectively plan their planting and treatment strategies to achieve the highest yields by using the information from drone recordings of planting and treatment activities. Drone technology has revolutionized the agriculture sector by offering innovative methods to boost productivity and efficiency. These unmanned aerial vehicles provide farmers with real-time data for precision farming, insect detection, and crop monitoring thanks to their advanced sensors and cameras. In this era of smart farming, drones are indispensable because they optimize resource utilization, reduce environmental impact, and eventually transform traditional farming practices.

II. LITERATURE REVIEW

This study observes the following researches for reference, **George IPATE (2015)** In this study, they introduced the basic general principles used in designing a quadcopter UAV, which has a wide applicability in modern agriculture. To some extent, the main goal in the development of precision farming is to replace the traditional agricultural practices. The use of drones for surveillance of greenhouses can increase crop yields by minimizing the cost of traveling on very large areas and remediation of the issues identified. **B.V. Rama Krishna (2017)** In this research, they find that the application of ADM in agriculture crop fields proved to be an increase in accuracy during data collection and information processing over transmission media. The enhancement of existing Drones with minor inclusions of Zigbee system improves the mobile communication facilities among smart phones, Wi-Fi based Laptops. It provides greater flexibility to Indian

farmers to overcome labour cost factor during cultivation of crops.**Sunil Karbharee Diwate (2018)** In this paper, they have described an architecture based on unmanned aerial vehicles (UAVs) means drone that can be employed to implement a control loop for agricultural applications where UAVs are responsible for seed sowing in the soil of farm. The process of applying the seeds is controlled by means of the feedback from the wireless sensors network deployed at seed container. **S.R. Kurkute (2018)** This study mainly Focus on selection of best compatible design for Drone system for Agriculture purpose. Some of the exiting implementation was discussed with their advantages and disadvantages. Finally, it is Conclude that if the system design with the use of Atmega 644PA then it will be the more efficient implementation. In line to this the experimentation and expected result also discussed for further implementation.**S. Ahirwar(2019)** This research argues that the required increase in food production can be achieved by adopting the advance technologies in agricultural production. The Use of advanced technologies such as drone in agriculture offer potential for facing several major or minor challenges.**R. B. Kalamkar (2020)** This Research suggest that adoption of modern technologies in agriculture, such as the use of drones or unmanned aerial vehicles (UAVs) can significantly enhance risk and damage assessments and revolutionize the way we prepare for and respond to disasters that affect the livelihoods of vulnerable farmers and fishers and the country's food security. **Karan Kumar Shaw (2020)** In this research they have described a design of a drone mounted spraying mechanism for Agricultural purpose and for spraying disinfectants. This method of spraying pesticides on Agricultural fields reduces the number of labours, time, cost and the risk involved to the personnel involved in spraying the liquids.**P.S. Mhetre (2020)** The main advantage of this project is that drone will be helpful for farmers in spraying fertilizers, pesticides and crop protection products while being controlled by a single person operating from a safe and secure location. As far as future enhancements are concerned, this project has ample scope. For the detection of various diseases on crops and moisture and temperature detection of the crop field. Thermal camera to work in stormy and heavy rain and bad weather.**P.M. Benson Mansingh (2021)** Plants are the essential source to tackle the issue of food starvation, air contamination, an unnatural weather change, and so on Horticulture creation is the way to take care of steadily developing populaces and is the significant type of revenue for most of the rustic poor. This venture helps the ranchers and research center where they are can undoubtedly secure their harvests and there will be expansion in development of creation in brief timeframe. As future improvement of the task is to build up the open mixed media (Audio/Video) about the illnesses. **Manvendra Kushvaha (2021)** Traditional practice achieved by farmers working in very specific farm-household systems, sustainable agriculture has procured its necessity, new technological strategies tread to achieve sustainability in agriculture including factors beyond the control of the household. agriculture drone regulatory frameworks are proved to be a positive approach concerning the importance in the growth of the agricultural field in India and it should be made best suited and prepared for the growth of Indian agriculture setup.**SHUBHANGI G. RAJPUT (2021)** Drones have already vastly altered in agriculture industry. Infact, drone use is becoming more useful to small farmers. In future there will be exponential growth in the area of drones as the cost of drones and agriculture drones in particular continue to drop and become easier to us. **Mohamad Hazwan Mohd Ghazali (2022)** This study surveys commercial agriculture drone and the applications of drone in precision agriculture performed by researchers such as crop spraying, soil analysis, mapping, crop monitoring, livestock farming, and seed planting. Currently, the applications of drone in precision agriculture are still not fully matured as some farmers especially in rural areas are not exposed to this kind of technology. **Gopal Dutta(2023)**, Drones have great potential to transform Indian agriculture with the advancement of technology in the future, the production of drones is expected to become economical. The modern youth are not attracted towards farming due to hard work and drudgery involved in it. The implication of drones may fascinate and encourage the youth towards agriculture. **Karthik kumar(2023)** Drone technology has a lot of potential for carrying out many agricultural tasks quickly and effectively. High initial costs and drone policy reforms are two of the most difficult obstacles to overcome before it becomes popular and farmer-friendly. Despite the drawbacks, the use of these tools and technologies in agriculture to disseminate knowledge about farming is expanding at a faster pace.**Mandakranta Chakraborty (2023)** Drone technology is a boon to agriculture. It enable precise application of inputs, manage weeds, save water, reduce fertilizer misuses,

thereby, improve resource use efficiencies. It also reduces the drudgery of farmers and ensures higher profitability and crop productivity.

III. OBJECTIVES OF STUDY

1. To know the advantages of using drone technology in agriculture.
2. To explore how drone technology improves agricultural efficiency.
3. To study the environmental benefits of drone technology in agriculture and understand its importance.

IV. RESEARCH METHODOLOGY

RESEARCH DESIGN

The basis of this research is descriptive in nature.

METHOD OF DATA COLLECTION

The present study is based on secondary data. The data's were collected from books, journals, and articles.

V. HISTORY OF DRONE TECHNOLOGY IN AGRICULTURE

Drones have been used in agriculture since the early 2000s, but it wasn't until the 2010s that the technology became widespread enough for farmers to employ it. As technology advanced, agricultural drones started to be utilised for additional activities, such as crop spraying and crop monitoring.

- Abraham Karem (born in 1937) is an unmanned aircraft designer with both fixed and rotating wings. He is recognized as the founding father of unmanned aerial vehicle (UAV) technology.
- Agribot Krishi Drone is India's 1st Type Certified Agriculture Drone approved by DGCA (Directorate General of Civil Aviation).
- The Japanese manufacturer Yamaha created the first agricultural drone in 2000 and it was known as the R-50, it was designed for crop mapping and field analysis.

Unmanned aerial vehicles (UAVs), commonly referred to as drones, have been utilized in farming and agriculture for a variety of purposes including crop monitoring, mapping, and spraying. Drones have been used in agriculture since the early 2000s, but it wasn't until the 2010s that the technology became widespread enough for farmers to employ it.

Farmers now frequently utilize drones that are outfitted with high-resolution cameras, sensors, and precise spraying systems to increase crop yields and cut expenses. More sophisticated technologies, such as artificial intelligence and machine learning, are anticipated to be used with drones in agriculture in the future.

CLASSIFICATION OF UNMANNED AIRCRAFT SYSTEMS

DGCA (Directorate General of Civil Aviation) classification based on weight (including payload)

- Nano: Less than or equal to 250 g
- Micro: Between 250 grams to 2kg.
- Small: Between 2 kg - 25 kg.
- Medium: Between 25 kg -150 kg.
- Large: More than 150 kg

WHAT DO AGRICULTURAL DRONES DO?

Agricultural drones allow farmers to monitor crop and livestock conditions from the air to keep watch for potential problems and help optimize field management. There are several functions that farmers and other agribusiness owners can use agricultural drone services for, including:

- Land imaging
- Surveying topography and boundaries
- Soil monitoring
- Livestock movement and counting
- Irrigation monitoring
- Spraying needs
- Collecting soil and water samples
- Troubleshooting

Depending on the type of information or task required of them, various sensors, camera lenses, hooks, sprayers and even small buckets to collect samples can be attached to drones. Data gathered by the drone streams back to a tablet or computer, providing useful information and photos about land, crops and livestock. The agri drone market grew to $1.2 billion in 2020, and analysts expect it to reach nearly $6 billion by 2025.

FUTURES OF DRONE TECHNOLOGY IN AGRICULTURE

The future of drone technology in agriculture is poised to bring about transformative changes, offering innovative solutions to address the evolving challenges faced by the agricultural industry. Here are some key aspects that highlight the future potential of drone technology in agriculture.

- **ADVANCED SENSING TECHNOLOGIES** Future drones will likely incorporate more advanced sensing technologies, including hyperspectral and LiDAR (Light Detection and Ranging) sensors. These sensors can provide even more detailed and precise information about crop health, soil composition, and environmental conditions. This heightened level of data granularity will enable farmers to make more informed decisions, leading to increased 7 productivity and resource efficiency.
- **AUTONOMY AND AI INTEGRATION** Advancements in artificial intelligence (AI) and machine learning algorithms will enable drones to autonomously analyze collected data and make real-time recommendations. AI-powered drones can detect and diagnose crop diseases, identify pests, and predict yield outcomes with greater accuracy. This integration of autonomy and AI will streamline agricultural operations, reducing the need for manual intervention and enhancing overall efficiency.
- **SWARM TECHNOLOGY** Future agricultural drones may operate in swarms, working collaboratively to cover larger areas more quickly and efficiently. Swarm technology can enable synchronized actions such as crop spraying, seeding, and monitoring across vast agricultural landscapes. By leveraging swarm intelligence, farmers can optimize resource allocation, reduce operational costs, and achieve greater precision in agricultural tasks.
- **ENERGY EFFICIENCY AND SUSTAINABILITY** Future drones are expected to become more energy-efficient, with longer flight times and improved battery technologies. Additionally, there will be a focus on developing environmentally sustainable drone materials and propulsion systems to minimize carbon emissions and ecological impact. By adopting greener drone technologies, agriculture can become more sustainable and environmentally friendly.
- **INTEGRATION WITH FARM MANAGEMENT SYSTEMS** Drones will be seamlessly integrated into farm management systems, enabling farmers to access real-time data insights and analytics from their drones through centralized platforms. This integration will facilitate better decision-making, allowing farmers to optimize resource allocation, track crop performance, and manage operations more effectively. Furthermore, drones will be interoperable with other precision agriculture technologies such as GPS-guided tractors and automated irrigation systems, creating a comprehensive and interconnected farming ecosystem.
- **REGULATORY FRAMEWORKS AND STANDARDS** As drone technology continues to advance, there will be a need for robust regulatory frameworks and industry standards to ensure safe and responsible drone operations in agriculture. Governments and regulatory bodies will play a crucial role in establishing guidelines for drone use, addressing concerns related to airspace management, privacy, and data security. Clear regulatory frameworks will promote the widespread adoption of drone technology in agriculture while ensuring compliance with legal requirements.

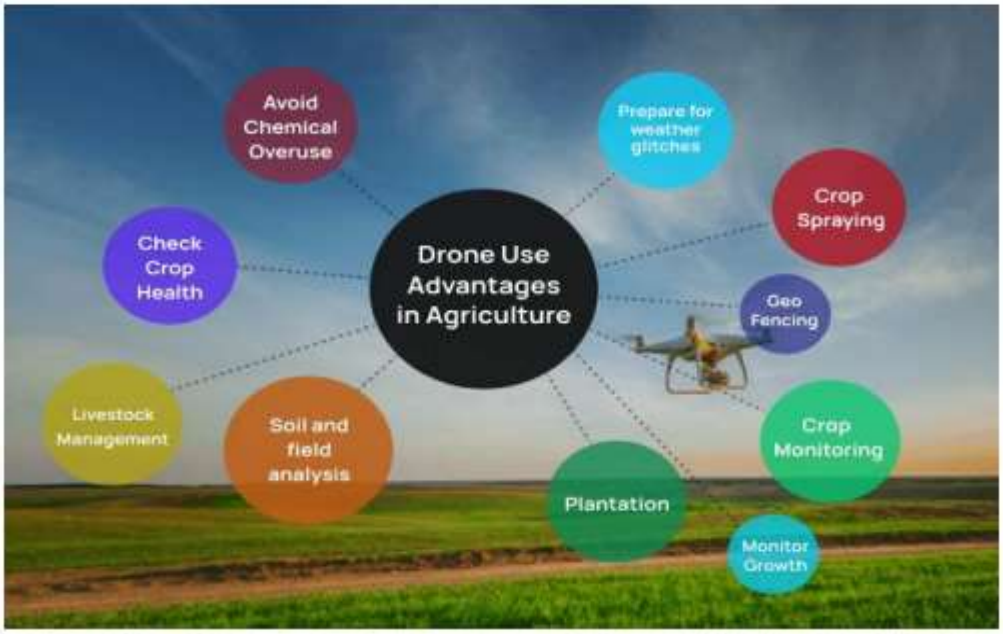
STEPS WERE TAKEN BY THE GOVERNMENT TO PROMOTE THE USE OF DRONES IN AGRICULTURE

- The agriculture ministry had released standard operating procedures (SOPs) for using drones in pesticide and nutrient application.
- Agriculture Ministry provides grant upto Rs. 10 lakhs to agricultural institutes for purchase of 8 drones.
- Union Finance Minister has announced in the Budget 2022-23 that the Centre will promote 'Kisan Drones' to help farmers assess crops, digitise land records, spray insecticides and nutrients.
- The government has notified the Drone Rules 2021 which is expected to make drone operations simpler for civilian drone operators.
- New Delhi has eased drone policies with mechanisms such as the Production Linked Incentive scheme and import bans paving the way for the domestic manufacturing sector.

ADVANTAGES OF DRONE TECHNOLOGY IN AGRICULTURE

Drone technology offers numerous advantages in agriculture, revolutionizing traditional farming practices and providing farmers with valuable tools to enhance productivity, efficiency, and sustainability.

- **Precision Farming** Drones enable precision agriculture by collecting detailed data on soil health, moisture levels, and crop conditions. This data allows farmers to make informed decisions about planting, fertilizing, and irrigation, optimizing resource utilization and maximizing yields.
- **Crop Monitoring and Management** Drones equipped with high-resolution cameras and sensors provide farmers with real-time insights into crop health, growth patterns, and pest infestations. This early detection of issues allows for timely intervention, reducing crop losses and minimizing the need for chemical inputs.
- **Cost Efficiency** Drones help farmers save time and money by automating tasks such as crop scouting, mapping, and spraying. They can cover large areas quickly and efficiently, reducing labor costs and operational expenses associated with traditional farming methods.
- **Improved Decision Making** The data collected by drones, including aerial imagery, multispectral images, and thermal maps, empowers farmers to make data-driven decisions about crop management practices. By analyzing this information, farmers can identify trends, assess risks, and implement strategies to optimize yields and profitability.
- **Environmental Sustainability** Drones promote environmentally sustainable farming practices by enabling targeted application of fertilizers, pesticides, and herbicides. By spraying inputs only where needed, drones reduce chemical usage, minimize runoff, and mitigate the negative impact of agriculture on ecosystems and water quality.
- **Accessibility** Drones are accessible to farmers of all scales, offering a cost-effective and versatile solution for agricultural operations. They can be deployed in diverse terrain and weather conditions, providing farmers with valuable insights and support throughout the growing season.
- **Safety** Drones improve safety on farms by reducing the need for manual labor in hazardous or challenging environments. They can access remote or hard-to-reach areas without putting human operators at risk, minimizing accidents and injuries associated with traditional farming practices.
- **Scalability** Drone technology is scalable and adaptable to different farm sizes and types, from small family farms to large commercial operations. Whether used for crop monitoring, spraying, or livestock management, drones can be customized to meet the specific needs and go also individual farmers.



DISADVANTAGES OF DRONE TECHNOLOGY IN AGRICULTURE

- **Regulatory Hurdles** One of the primary challenges facing the application of drone technology in agriculture is navigating complex and evolving regulatory frameworks. Regulations governing drone operations vary between countries and regions and often impose restrictions on aspects such as flight altitude, airspace access, and operator certifications. Adhering to these regulations adds complexity and uncertainty to drone deployment in agricultural settings.
- **Cost of Investment** The initial investment required for acquiring drones and associated equipment can be prohibitive for many farmers, especially smallholders or those operating on tight budgets. Additionally, ongoing costs such as maintenance, training, and insurance further add to the financial burden. Achieving a positive return on investment may take time, particularly in regions with low crop values or uncertain market conditions.
- **Technical Complexity** Operating drones effectively in agricultural settings requires technical expertise in piloting, data collection, and analysis. Farmers may lack the necessary skills and training to deploy drones optimally, leading to underutilization or inefficient use. Moreover, integrating drone-collected data with existing farm management systems and workflows can be challenging, requiring additional technical support and resources.
- **Limited Battery Life and Flight Time** Most agricultural drones have limited battery life and flight time, typically ranging from 20 to 40 minutes per charge. This restricts their coverage area and operational efficiency, especially in large-scale farming operations. Overcoming this limitation requires advancements in battery technology or the development of drone swarming and recharging infrastructure, which may not be feasible in all environments.
- **Data Management and Privacy Concerns** Drones generate vast amounts of data through aerial imaging, sensors, and other onboard technologies. Managing and analyzing this data effectively can be overwhelming for farmers, particularly those lacking data analytics expertise or adequate computational resources. Moreover, concerns about data privacy and security may deter farmers from adopting drone technology, especially in regions with stringent data protection regulations.
- **Weather and Environmental Limitations** Adverse weather conditions such as high winds, rain, or fog can impede drone operations and compromise data quality. Drones may struggle to maintain stability and accuracy in challenging weather environments, limiting their reliability and effectiveness. Additionally, environmental factors such as terrain complexity, vegetation density, and altitude variations can further constrain drone performance in agricultural settings.
- **Public Perception and Acceptance** Finally, public perception and acceptance of drones in agriculture can influence their adoption and integration into farming practices. Concerns about noise pollution, visual intrusion, and safety risks may arise, particularly in densely populated or residential areas. Building trust and addressing community concerns through education, outreach, and transparent communication is essential for fostering acceptance of drone technology in agriculture.
- **Initial Investment Costs** Acquiring drones and related equipment can represent a significant upfront investment for farmers, particularly for small-scale operations or those with limited financial

resources. Additionally, on going maintenance, repairs, and software updates can incur additional costs over time.

VI. THINGS TO CONSIDER BEFORE DEVELOPING DRONE SOLUTIONS IN AGRICULTURE

Drones are accessible and relatively inexpensive, yet there are important things to take into account before implementing drone solutions. The steps involved in transforming your farm into a drone-enhanced agritech business include the 5 following aspects:

- **DETERMINING GOALS** Agriculture drones have a range of applications: field and crop monitoring, seed planting, cattle surveillance, etc. What do you want them to do? Determine the core farm processes that you believe would benefit most from using drones.
- **STUDYING THE LEGISLATION** Better yet, hire a lawyer to take care of all legal aspects involved in commercial drone usage. These will vary depending on your country or state of residence. Register your drone if you have to and find out which types of drones you can legally use in your area. Also, carefully study security instructions on flying your drone, since you will be held accountable in case of accidents.
- **DECIDING ON THE DRONE HARDWARE** Based on the tasks you want to accomplish, it is necessary to decide which hardware to equip your drone with. For example, for crop health monitoring, your drone will need an infrared camera. If you want it to estimate soil condition, it will need appropriate sensors, etc. In a nutshell, your drone capabilities will depend on the tasks you have in mind.
- **SELECTING THE TYPE OF DRONE SOFTWARE** The data your drone collects will have to be processed with agriculture drone software. You will most likely need navigation and flight management software, mapping, as well as data and image processing software, depending on your drone type. In some cases, ready-made, out-of-the-box software won't work and you will need custom-made solutions.
- **DEVELOPING CUSTOM-MADE DRONE SOFTWARE** At the initial stage, this will require an understanding of the data collection, analysis, and visualization process. Further on, you will need in-depth knowledge of plant physiology to instruct the software algorithms to recognize certain patterns indicating plant conditions (the same goes for soil conditions or cattle behavior patterns for livestock farms).

VII. USES OF DRONE TECHNOLOGY IN AGRICULTURE

- **Simplified Crop Surveillance** Drones are extensively utilised in agricultural surveillance. Monitoring agricultural progress from the moment seeds are sown until harvest keeps track of concerns such as irrigation, plant disease, and soil quality.Farmers can readily identify portions of the field that are not producing healthy crops, determine what the problem is, and solely target that region for any treatment that may be necessary by employing remote sensing technology.
- **Accurate Field Monitoring** Field conditions must be monitored to ensure a healthy planting. Drones help farmers and agronomists create exact maps and 3D models of the region using a technique known as drone photogrammetry. Drones may be outfitted with cameras, such as RGB, multispectral, and thermal cameras, allowing farmers to access various data types.These maps' data will assist farmers in making the required modifications to guarantee that the land remains healthy and productive
- **Faster Planting and Seeding** One of the primary advantages of employing innovative technology in agriculture is the reduced time required to execute several chores. Ten drones can plant four million seeds each day. Currently, automated drone seeders are primarily utilised in the forestry business, but they have the potential for broader usage. Many of these procedures are semiautomated since they may be carried out using intelligent flight modes, resulting in less time spent on the field and saving farmers money on labour equipment.
- **Safer Spray Treatment** Pests and plant diseases will always be a problem for farmers. Drones spray crops with water, fertilisers, pesticides, and herbicides. Agro-spraying with drones is common in Southeast Asia and South Korea. Drone sprayers eliminate personnel needing to travel the field with dangerous backpack sprayers.

VIII. GROWTH OF DRONE TECHNOLOGY IN AGRICULTURE

- The growth of drone technology in agriculture has been significant in recent years. As technology has advanced, drones have become more affordable and easier to operate, leading to more widespread adoption among farmers. They are now used for a variety of tasks, including crop spraying, crop monitoring, mapping, and precision agriculture.
- The introduction of GPS and other technologies in drones for agriculture has greatly improved the precision and efficiency of tasks such as crop spraying, crop monitoring, and mapping.
- GPS technology allows drones to navigate to specific locations and maintain a precise flight path, which is essential for tasks such as crop spraying and planting. Drones equipped with GPS can fly 13

predetermined patterns over a field, ensuring that each section of the field is treated evenly and reducing the potential for overlap.

- Drones are becoming more affordable and accessible for agriculture as technology advances and costs decrease. The decrease in cost and increase in accessibility has led to wider adoption of drones among farmers, particularly small-scale farmers who may not have previously had access to this technology.

IX. SUGGESTION

Drone technology in agriculture presents numerous advantages such as precision crop monitoring, soil analysis, and targeted pesticide application. Drones equipped with specialized sensors and cameras can provide real-time data on crop health, helping farmers identify areas of stress or disease. Additionally, drones can be used for aerial mapping to create detailed topographic maps and identify irrigation needs. Moreover, drones can facilitate precision spraying, reducing chemical usage and minimizing environmental impact. Overall, integrating drone technology can enhance productivity, sustainability, and cost-effectiveness in agriculture.

X. CONCLUSION

Drones have great potential to transform Indian agriculture. With the advancement of technology in the future, the production of drones is expected to become economical. The modern youth are not attracted towards farming due to hard work and drudgery involved in it. The implication of drones may fascinate and encourage the youth towards agriculture. Drones will enable farmers to know more about their fields. Therefore, farmers will be assisted with producing more food while using fewer chemicals. Nearly all farmers who have made use of drones have achieved some form of benefit. They can make more efficient use of their land, exterminate pests before they destroy entire crops, adjust the soil quality to improve growth in problem areas, improve irrigation to plants suffering from heat stress and track fires before they get out of control. Therefore, drones may become part and parcel of agriculture in the future by helping farmers in managing their fields and resources in a better and sustainable way.

XI. REFERENCES

- George IPATE (2015) Research on the use of Drones in Precision Agriculture, Volume .77, Issue.04, ISSN: 1454- 2358, PP: 263- 274.
- B.V. Rama Krishna (2018) Agriculture Drone Model with Zigbee Network, Volume. 06, Issue.10, ISSN (Print): 2320- 8765, ISSN (Online): 2278- 8875, PP: 7445- 7450.
- Sunil Karbharee Diwate (2018) Design and Development of Application Specific Drone Machine for Seed Sowing, Volume. 05, Issue. 05, E-ISSN: 2395- 0056, P- ISSN: 2395- 0072, PP:4003- 4007.
- S.R. Kurkute(2018), Drones for Smart Agriculture: A Technical Report, Volume. 06, Issue. 4, ISSN: 2321-9653, PP: 341- 346.
- S. Ahirwar(2019), Application of Drone in Agriculture, College of Agricultural Engineering and technology, Anand agriculture

al university, Volume.8, Number. 01, ISSN: 2319- 7706, PP: 2500- 2505.

- R. B. Kalamkar1 (2020), Drone and its Applications in Agriculture, Volume. 09, Number.06, ISSN: 2319-7706, PP: 3022- 3026. • Karan Kumar Shaw (2020), Design and Development of a Drone for Spraying Pesticides, Fertilizers and Disinfectants, Volume. 09, Issue. 05, ISSN: 2278- 0181, PP: 1181- 1185.
- P.S. Mhetre (2020), Agriculture Drone for Fertilizer Spraying, Volume. 02, Issue. 06, EISSN:2582- 5208, PP: 771- 777.
- P.M. Benson Mansingh (2021), Drone Based Precision Agriculture System, Volume. 03, Issue.03, E-ISSN: 2582- 5208, PP: 1591- 1595.
- Manvendra Kushvaha (2021), Agriculture Drone, Volume. 03, Issue. 04, E- ISSN: 2582- 5208, PP: 2359-2361.
- Shubhangi G. Rajput (2021), A Review on Agricultural Drone used in Smart Farming, Volume. 08, Issue. 03, E- ISSN: 2395- 0056, P- ISSN: 2395- 0056, PP: 313- 316.
- Mohamad Hazwan Mohd Ghazali (2022), Drone Implementation in Precision Agriculture -A Survey, Volume. 12, Issue. 04, E- ISSN: 2250- 2459, PP: 67- 77.
- Gopal Dutta1 (2023), Application of drone in agriculture: A review, Volume. 08, Issue. 05, P-ISSN: 2349–8528, E- ISSN: 2321–4902, PP: 181- 187.
- Karthik kumar (2023), Applications of Drone in Agriculture, Tamil Nadu Agricultural University, Coimbatore – 03, ISBN: 978-93-5680-148-6, PP: 77- 85.
- Mandakranta Chakraborty (2023), Drone Technology in Agriculture, Article ID: 40303 Volume. 05, Issue. 02, E- ISSN: 2581- 8317, PP: 290- 292.