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FARMERS AWARENESS AND PERCEPTION REGARDING AGRICULTURAL DRONE TECHNOLOGY

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The agricultural sector is increasingly adopting technological innovations to boost productivity and sustainability. Among these advancements, drone technology an integral part of precision agriculture is gaining widespread recognition. The study examines the level of awareness and perception of drone technology among farmers in Saurashtra region, where agriculture remains a vital source of livelihood. The study was conducted in Junagadh, Rajkot and Porbandar and Gir Somnath districts of Saurashtra region as pilot study. The simple random sampling method were used for selection of respondents those who are known or got the training on drone technology. From these districts, total 95 farmers were selected as sample to evaluate their awareness and perception of about drones technology. Data were collected through structured interviews and questionnaires, analysed using statistical methods such as frequency, percentage and mean scores to interpret the response trends.

ABSTRACT

The results of the research study indicated that farmers' having the knowledge of drone technology is highest for its application in spraying agrochemicals (70.53 per cent), followed by pest and disease control (63.16 per cent), irrigation monitoring and management (60.00 per cent), crop monitoring and health assessment (57.89 per cent), planting and seeding (44.21 per cent) and soil and field analysis (43.16 per cent), crop mapping and surveying (42.11 per cent). Farmers showed positive perceptions of drones' efficiency and precision were; use of drones minimizes the need for labour intensive tasks such as spraying, initially high upfront cost of drones prevents many farmers from adopting them, limited access to drone suppliers or rental services, improved the effectiveness of pest control and fertilization efforts, save money by reducing the use of costly inputs like pesticides and water, help automate repetitive tasks, allowing me to focus on other important aspects of farming, allows for more precise application of fertilizers, pesticides, and water, monitor water usage and reduce wastage, reliability of drones in rural areas with limited connectivity is a concern and reduce the environmental impact by applying chemicals only where needed. This study emphasizes the critical role of integrating drone technology into agriculture to foster sustainable and productive farming practices, essential to addressing the growing global food demand.

Key words: awareness; perception and agricultural drone technology

Introduction

According to the Press Information Bureau (2021), the sector of agriculture, although it contributes to 20.2 per cent of the Gross Domestic Product (GDP) of India, it gambles with various constraints such as abnormal monsoons, production related issue, low productivity, labour shortage, price fluctuations, etc. Agriculture is the prime work source for man of the rural households. The FAO report on India at a Glance, 2022 in its report have

insisted that 70 per cent of the rural households still depend on agriculture and about 82 per cent of the farm households are small and marginal. It is the dire need of all the stakeholders who are involved around agriculture to look into this situation seriously and find out path breaking ways to achieve sustainability for our younger generation. Automation in agriculture is an emerging subject across the world. In the current trend, the concept of Artificial Intelligence has found many applications in

building solutions for agriculture related problems, which not only empower the farmers to continue farming amidst eradicating natural resources and also would improve the quality and ensure quick market penetration of various crops. Of all these, a pivotal role is being played by the technology of Unmanned Aerial Vehicles (UAVs), commonly referred to as Drones for agricultural purposes.

Use of Drones for the Crop-protection in India is new and the country is gaining experience. Indian Council of Agricultural Research (ICAR) initiated a network program during September, 2021 where in research on use of Drones and Artificial Intelligence (AI) for timely monitoring of crop growth, health and managing it with enhanced input use efficiency were taken up. Drone and AI technology are used to monitor near real-time crop health. Drone is also used for variable rate technology for pesticide and liquid fertilizer applications, mapping of water spread area, water sampling, mapping macrophyte infestation and aquaculture management practices, etc. Drone and AI technology are also used for precision livestock farming, particularly its health monitoring. For enhancing farmers' income, the emphasis is on adopting a multi-dimensional strategy, which includes increase in production through creation of resources for improving irrigation; effective use of inputs; reduction of post-harvest losses; value addition; reforms in agriculture marketing; minimizing risk and providing security and assistance, and promotion of allied activities. The Government has adopted several developmental programmes, schemes, reforms and policies that focus on higher incomes for the farmers.

The integration of advanced technologies into agriculture has revolutionized farming practices, improving efficiency, sustainability, and productivity. One such innovation is the use of agricultural drones, which are becoming increasingly popular for monitoring crop health, assessing soil conditions, applying fertilizers and pesticides, and even planting seeds. These unmanned aerial vehicles (UAVs) have the potential to transform traditional agricultural methods by providing real-time, high-resolution data that allows farmers to make more informed decisions.

However, the adoption of agricultural drone technology is not uniform across the agricultural sector. Farmers' awareness and perception of this technology play a critical role in its acceptance and widespread use. While some farmers are enthusiastic about the benefits drones offer, such as cost savings, increased precision and labour efficiency, others may be hesitant due to factors such as high costs, lack of technical knowledge,

or concerns about the reliability and effectiveness of drones in real-world farming conditions.

Understanding farmers' awareness of drone technology involves examining their familiarity with its capabilities, advantages, and potential challenges. Perception, on the other hand, relates to how farmers view drones in terms of their usefulness, practicality and the impact they may have on their farming operations. Factors influencing perception may include age, education level, farm size, technological exposure and region-specific agricultural practices. Agarwal *et al.*, (2022) finds that farmers' perceptions are influenced by their technological literacy, income levels, and prior exposure to modern agricultural technologies. While many farmers recognized the potential benefits of drones, such as improved crop monitoring and pesticide management, a lack of technical knowledge and high upfront costs remained significant barriers to adoption.

The utilization of agricultural drones is on the rise among Indian farmers due to their transformative potential in farming practices. Moreover, the Indian government is actively endorsing drone usage in agriculture and has implemented various policies to incentivize and facilitate their integration. In Gujarat, farmers have begun embracing this cutting-edge technology, particularly for spraying insecticides and pesticides on cotton, groundnut, pigeonpea, and fertilizing paddy fields through drone spraying. Even some NGOs, FPOs and Panchayats in the state are initiating projects to assist farmers in adopting drones, leading to time and labour savings. In Gujarat, "Drone Didi" is famous for using drone on rent basis. However, at present, there is limited information regarding the farmers' awareness and adoption of agricultural drones. This study is focused on the "Farmers Awareness and Perception Regarding Agricultural Drone Technology" in Saurashtra region of Gujarat state and how different demographical characteristics affect the awareness and perception towards agricultural drones.

Material and Methods

Based on the data obtained by a pilot survey of the units offering drones on a rental basis to the farmers for spraying chemicals to the crops in four districts of Saurashtra region *viz.* Junagadh, Rajkot, Porbandar and Gir Somnath were selected as study area. The purposively selected these four districts due to these having nearer to Junagadh Agricultural University and convenient to investigators. Additionally, the districts have growing interest in precision farming techniques, and its proximity to research institutions and agricultural universities makes it a prime area for testing and implementing innovations

in farming. Respondents for the study were selected by simple random sampling technique. To ensure an unbiased and representative sample, a simple random sampling technique was employed. Wherein from each district, farmers have received agricultural drone technology training which was providing by Krushi Vigyan Kendra in each selected district. And also some of those farmers were used drone technology in their own field on rent base.

The data were collected using a pre-tested and well-structured interview schedule and a well-designed questionnaire tailored to gather information on drone technology awareness and perception in agriculture. The type of questionnaire described here is a structured questionnaire, which is commonly used in surveys to collect quantitative data. Structured questionnaires often include a mix of closed-ended questions and occasionally some open-ended questions for qualitative insights. The response was recorded on a five-point continuum of extremely unlikely, somewhat unlikely, likely, somewhat likely, extremely likely factor assigning scores of 1, 2, 3, 4 and 5, respectively and vice versa. The responses were obtained. The responses were subjected to percentage, mean score and ranked were assigned, analysis and the results were tabulated and explained.

Results and Discussion

The result of the research regarding awareness and perception of farmers are described as under.

Farmer's Awareness regarding use of Drone Technology and its Application

Drones are transforming how agriculture and farming are done. By implementing drone technology, farms and agriculture businesses can improve crop yields, save time, and make land management decisions that'll improve long-term success. Drone technology is providing innovative solutions for various farming practices. From monitoring crop health to managing irrigation, drones help improve efficiency and precision. However, the extents of awareness among farmers about the various applications of drones are playing a crucial role in determining the adoption of these technologies.

Farmers' awareness of the different applications of drone technology in agriculture is presented in Table 2. Which are offering insights into where awareness is higher and where more knowledge dissemination might be needed for applications of drone technology?

Spraying of agro chemicals

This is most important operation in crop life cycle. Crops require regular fertilization and spraying in order

Table 1: Number of respondents chosen for the study from the selected districts.

Sr. No.	Name of selected district	A Selected number of respondents
1	Junagadh	24
2	Rajkot	24
3	Porbandar	24
4	Gir Somnath	23
	Total	95

to maintain high yields. The majority of the farmers were having highest awareness (70.53 per cent) about use of drones for spraying agrochemicals. This indicates a strong recognition of drones as a valuable tool for improving the efficiency and precision of pesticide and fertilizer application, potentially reducing labour costs and chemical waste. Drones can spray pesticides, herbicides, and fertilizers with greater precision than manual methods, reducing wastage and environmental impact while enhancing coverage in large fields. With GPS technology, drones can accurately target areas that require treatment, making them more appealing to farmers looking to reduce labour costs. This was supported by the Uche *et al.*, (2021) and Chiranjeeb *et al.*, (2022).

Drones can be equipped with large reservoirs, which can be filled with fertilizers, herbicides, or pesticides. Using drones for crop spraying is much safer and cost-effective. Drones can even be operated completely autonomously and programmed to run on specific schedules and routes.

Pest and disease control

From the above Table 2 indicated that majority (63.16 per cent) of the farmers were highly aware of drone's role in identifying and managing pests and diseases, reflecting the growing use of drones for crop protection. The ability of drones to identify, monitor, and manage

Table 2: Farmer's Awareness regarding use of Drone Technology and its Application (n=95).

Sr. No.	Farmers Awareness	Number of Respondents	Percentage
1.	Crop spraying and spot spraying agrochemicals	67	70.53
2.	Pest and disease control	60	63.16
3.	Irrigation monitoring and management	57	60.00
4.	Crop monitoring and health assessment	55	57.89
5.	Planting and seeding	42	44.21
6.	Soil and field analysis	41	43.16
7.	Crop mapping and surveying	40	42.11
8.	Yield estimation	32	33.68
9.	Real-time livestock monitoring	24	25.26

pests and diseases is well understood by farmers, particularly those involved in high-value crops.

The study results are similar to previous findings by Abbas *et al.*, (2023), which highlighted the efficacy of drones equipped with sensors for early detection of pest infestation or disease stress. They also suggested that the use of drones proved advantageous in identifying crop health issues before they were visible to the human eye, facilitating timely interventions. The alignment of these findings underscores the potential of drone technology in enhancing agricultural monitoring and promoting smarter farming practices. In the same way, SS VC (2024) said that the increasing unpredictability of pest outbreaks due to climate change has heightened the demand for more advanced monitoring systems, further boosting farmers' interest in drone technology for pest and disease management.

Irrigation monitoring and management

Three fifth (60.00 per cent) of farmers were awareness about irrigation monitoring and management. These farmers were recognized drones' ability to optimize water use by providing detailed insights into field conditions, monitoring and irrigation needs.

The findings of this study regarding the optimization of irrigation schedules through drone technology align with previous research by Zhang and Kovacs (2022), which emphasized the economic benefits of drone use in precision agriculture. Their study demonstrated that drones can enhance irrigation efficiency, thus reducing water wastage and maximizing crop yields, particularly in areas susceptible to drought. Moreover, Saikanth *et al.*, (2023) further support these results by discussing the role of drones in promoting sustainable agricultural practices. They highlighted that drone contribute significantly to water conservation efforts, which is increasingly vital in the context of global water scarcity concerns.

Crop monitoring and health assessment

Majority (57.89 per cent) of the farmers were aware of the benefits of using drones for crop monitoring and health assessments, which can significantly improve decision-making regarding crop management and yield optimization. Drones equipped with multispectral or hyperspectral cameras can capture data beyond the visible spectrum, allowing for more accurate assessments of plant health.

The findings of this study were supported Barbedo (2019) which highlight the advantages of drone technology for crop monitoring in large farms, are consistent. Barbedo emphasized that unmanned aerial

vehicles (UAVs) equipped with imaging sensors provide an efficient alternative to manual monitoring, significantly reducing both time and costs associated with crop assessment on expansive agricultural lands. Moreover, the ability of drones to quickly gather and analyse data enables farmers to detect plant stresses more efficiently than traditional methods.

Planting and seeding

Less than half (44.21 per cent) of the farmers were aware regarding planting and seeding, suggesting an opportunity to educate farmers about how drones can automate and enhance the efficiency of these labour-intensive tasks. Drones can drop seeds directly into the soil, especially in hard-to-reach areas or for reforestation projects. While this is an emerging technology, it has not yet gained widespread use in conventional agriculture.

Soil and field analysis

More than two fifth (43.16 per cent) of the farmers were understand the potential of drones in soil and field analysis, emphasizing the importance of data-driven insights for enhancing soil management practices and improving crop outcomes. Drones can map soil variations, enabling farmers to make informed decisions on planting patterns, irrigation and fertilizer use. This promotes precision agriculture, where inputs are tailored to specific field conditions, this supported by Shaheb (2022).

Crop mapping and surveying

More than two fifth (42.11 per cent) of farmers were aware about crop mapping and surveying. Drone technology is the effectiveness of large-scale crop and acreage monitoring. In the past, satellite or plane imagery was used to help get a large-scale view of the farm, while helping to spot potential issues. With drone mapping and surveying, technology decisions can now be made based on real-time data, not out-dated imagery, or best-practice guesswork.

Yield estimation

Slightly more than one third (33.68 per cent) of the farmers were aware about yield estimation, there is a potential to introduce farmers to how drones can accurately predict yields and assist in planning harvest and sales strategies. Farmers are also known that this is particularly useful for large-scale farms looking to optimize market timing and financial forecasting. Drones equipped with sensors can assess crop conditions and make yield predictions based on growth patterns, soil moisture, and plant health data.

Real-time Livestock monitoring

Only 25.26 per cent farmers were aware regarding

Table 3: Farmer's Perception on Drone Technology (n=95).

Sr. No.	Statements related to farmer's perception on drone technology	Mean score	Rank
1	Drones are simple to learn and operate for most farming operations/tasks.	3.63	XVI
2	The initial cost of drones is high so, it prevents many farmers from adopting them.	4.79	I
3	I have limited access to drone suppliers or rental services in my area.	4.32	VI
4	Drones make it easier to monitor larger area quickly and efficiently in short time.	4.00	XII
5	Drone technology has improved the effectiveness of my insect pest control.	4.21	VIII
6	Drone technology has improved the effectiveness of chemical fertilizer efforts.	4.05	XI
7	Use of drones allows for better precision in field management, reducing waste.	4.26	VII
8	As compared to manual farm inspections, through Drones significantly reduce the time spent.	4.21	VIII
9	It minimizes the need for labour-intensive tasks, such as spraying.	4.74	II
10	It help automate repetitive tasks, allowing me to focus on other important aspects of farming	3.26	XVII
11	Farmers are aware that drones provide accurate and detailed information about crop health.	3.68	XV
12	Farmers are aware that drones are useful for more accurate application of fertilizers, pesticides, and water	4.16	IX
13	Drones useful to me better insights into soil conditions, leading to more informed decisions.	3.21	XVIII
14	Drones reduce the environmental impact by applying chemicals only where needed.	4.37	V
15	I use drones, it helps me monitor water usage and reduce excess use of water.	4.42	IV
16	I use drones, it reduces over-reliance on use of fertilizers and pesticides, promoting sustainability	3.79	XIV
17	Drones help to me, it save money by reducing the use of costly inputs like pesticides, fertilizer and water.	4.32	VI
18	The repairs and maintenance cost of drone is a challenge for long-term use.	3.68	XV
19	I know that the use of drones provide economic benefits by enhancing yield quality and quantity.	3.63	XVI
20	Training is an important component to use drones technology effectively in my various farm operations.	3.84	XIII
21	The technical knowledge required for operating drones is a barrier for most illiterate farmers.	2.74	XIX
22	More than one training programs are needed to understand how to integrate drones into their farming practices	4.11	X
23	Farmers need more knowledge and exposure to the potential applications of drones technology	4.16	IX
24	Government subsidies have helped make drone technology more affordable for farmers.	4.42	IV
25	More government and NGOs support is needed to encourage the widespread use of drones in farming	4.58	III
26	The reliability of drones in rural areas with limited connectivity is a concern	3.79	XIV

drone use for livestock monitoring. Most of the farmers are unknown and likely due to its niche application or the fact that many farmers in the region focus on crop farming rather than livestock. Drones can track livestock in large or difficult terrain, monitor their health, and even assist in herding. This is especially useful for large ranches or remote areas, but smaller farmers may not see the immediate benefit.

Farmer's Perception towards Drone Technology

Perception is our recognition and interpretation of sensory information. Perception also includes how we respond to the information. We can think of perception as a process where we take in sensory information from our environment and use that information in order to interact with our environment. It is a belief or opinion, often held by many people and based on how things seem.

From the Table 2 indicated that farmer's perceptions for drone technology show a mix of ease and challenges. The initial cost of drones is high so, it prevents many farmers from adopting them (mean score 4.79) were got first ranked, followed by minimizes the need for labour-intensive tasks, such as spraying (4.74) and more

government and NGOs support is needed to encourage the widespread use of drones in farming (4.58) with second and third ranked, respectively. This suggests that although farmers recognize the potential benefits of using drones, the financial burden associated with purchasing the technology limits widespread adoption.

In addition, farmers perceive drones as highly efficient and effective tools in agriculture to use drones, it helps me monitor water usage and reduce excess use of water with mean 4.42 and Government subsidies have helped make drone technology more affordable for farmers with mean 4.42 were both got equal fourth ranked. In the same way, equal ranked (fifth) were got drones are useful for more accurate application of fertilizers, pesticides, and water (4.16) and farmers need more knowledge and exposure to the potential applications of drones technology (4.16). Farmers' awareness and knowledge regarding drone technology in agriculture appear to be limited. Ultimately, farmers acknowledge both the cost-saving and economic benefits of drones, though challenges remain. The findings of this study regarding the economic and challenges of drone use in

agriculture are in alignment with the conclusions drawn by Zhang and Kovacs (2022). Zhang and Kovacs also emphasized that drones contribute to more efficient resource management and can lead to overall cost savings in precision agriculture.

Farmers perceive drones as having a positive impact on environmental sustainability. Farmers are perception regarding drones reduce the environmental impact by applying chemicals only where needed with mean score 4.37, I have limited access to drone suppliers or rental services in my area. (4.32) and drones help to me, it save money by reducing the use of costly inputs like pesticides, fertilizer and water. (4.32) were got sixth and seventh ranked, respectively.

The majority believe that farmers regarding use of drones allows for better precision in field management, reducing waste (4.26), drone technology has improved the effectiveness of my insect pest control (4.21) and as compared to manual farm inspections, through drones significantly reduce the time spent (4.21) had received 8th, 9th and 10th ranked, respectively.

Farmers express a high level of confidence in the training they have received for using drones in their farm operations, among these they said that more than one training programs are needed to understand how to integrate drones into their farming practices (4.11), drone technology has improved the effectiveness of chemical fertilizer efforts (4.05), drones make it easier to monitor larger area quickly and efficiently in short time (4.00), training is an important component to use drones technology effectively in my various farm operations (3.84). I use drones; it reduces over-reliance on use of fertilizers and pesticides, promoting sustainability (3.79) and the reliability of drones in rural areas with limited connectivity is a concern (3.79) were got 11th, 12th, 13th, 14th and 15th ranked, respectively.

Farmers express moderate concerns regarding the risks and challenges of using drones in agriculture. Farmers are aware that drones provide accurate and detailed information about crop health (3.68), the repairs and maintenance cost of drone is a challenge for long-term use (3.68), drones are simple to learn and operate for most farming operations/tasks (3.63), I know that the use of drones provide economic benefits by enhancing yield quality and quantity (3.63), it help automate repetitive tasks, allowing me to focus on other important aspects of farming (3.26), Drones useful to me better insights into soil conditions, leading to more informed decisions (3.21) and technical knowledge required for operating drones is a barrier for most illiterate farmers (2.74). This indicates

a significant opportunity for educational initiatives and outreach programs aimed at increasing awareness and understanding of how drones can be effectively utilized in farming, which could ultimately enhance adoption rates and maximize the technology's benefits.

Conclusion

From the above discussion, it can be concluded that the high levels of awareness among farmers regarding highest knowledge of drone technology for its application in spraying agrochemicals (70.53 per cent), followed by pest and disease control (63.16 per cent), irrigation monitoring and management (60.00 per cent), crop monitoring and health assessment (57.89 per cent), planting and seeding (44.21 per cent) and soil and field analysis (43.16 per cent), crop mapping and surveying (42.11 per cent), yield estimation (33.68 per cent) and real-time livestock monitoring (25.26 per cent) points to opportunities for data-driven insights that can increase agricultural productivity and economic viability. The study highlights that while farmers show strong awareness of drone applications in agrochemical spraying, pest control, and irrigation management, there remains a notable knowledge gap in areas like yield estimation and livestock monitoring.

Economic concerns is that the initial cost of drones is high so, it prevents many farmers from adopting them, followed by minimizes the need for labour-intensive tasks, such as spraying and more government and NGOs support is needed to encourage the widespread use of drones in farming. To use drones, it helps me monitor water usage and reduce excess use of water and Government subsidies have helped make drone technology more affordable for farmers. Drones are useful for more accurate application of fertilizers, pesticides, and water and farmers need more knowledge and exposure to the potential applications of drones technology.

Farmers are perception regarding drones reduce the environmental impact by applying chemicals only where needed, I have limited access to drone suppliers or rental services in my area and drones help to me, it save money by reducing the use of costly inputs like pesticides, fertilizer and water. Farmers recognize the environmental benefits of precision agriculture, yet they express concerns about the durability of drones in extreme weather and logistical challenges in remote areas. However, the expressed need for more training and knowledge dissemination emphasizes the importance of targeted educational initiatives to empower farmers to fully leverage these technologies.

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