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FACTORS AFFECTING PADDY FARMERS IN USING DRONES

MOHD SAZILI SHAHIBI[1], NORHAYATI HUSSIN[2] , ZAHARUDIN IBRAHIM[3] , AMER SHAKIR ZAINOL[4] ,MUHAMMAD ZAFFRI MOHD ZAZMI[5]

[1]Professor, College of Computing, Informatics and Media, University Teknologi MARA (UiTM), Shah Alam, Selangor, Malaysia

[2]Associate Professor, College of Computing, Informatics and Media, University Teknologi MARA (UiTM), Shah Alam, Selangor, Malaysia

[3]Associate Professor, College of Computing, Informatics and Media, University Teknologi MARA (UiTM), Shah Alam, Selangor, Malaysia

[4]Professor, College of Creative Arts, University Teknologi MARA (UiTM), Shah Alam, Selangor, Malaysia

[5]Postgraduate student, College of Computing, Informatics and Media, University Teknologi MARA (UiTM), Shah Alam, Selangor, Malaysia

E-mail: [1]mohdsazili@uitm.edu.my [2]yatihussin@uitm.edu.my,[3]zahar347@uitm.edu.my, [4]amers781@uitm.edu.my, [5]zaffrizaff@gmail.com
Corresponding author : [2]yatihussin@uitm.edu.my

ABSTRACT

In Malaysia, the agriculture industry is the most promising, but it is now facing several issues, one of which is the scarcity of the workforce for farming. Extreme weather conditions, an inadequate supply and ineffective fertilizer application, infections, diseases, allergies, and other health issues brought on by chemical applications (fungicides, pesticides, insecticides, etc.) or insect or animal bites are additional issues or difficulties. Drones have shown to be one of the approaches that enable quick and non-destructive examination of the air quality, physical characteristics of the components of soil, or crop growth to address some of the difficulties faced in agriculture through the use of sustainable ICTs. As a result, farmers are turning to cutting-edge drone technology to solve these issues quickly and effectively. Drones can gather information on various topics, including crop yields, livestock health, soil quality, nutrient assessments, weather patterns, and rainfall totals. However, there is none of the literature focused on the advantages of drone usage among paddy farmers in Malaysia. Therefore, this research aims to identify the factors affecting Malaysian paddy farmers using drones. This research collects data from interviews with ten paddy farmers who own agriculture drones to accomplish this objective. The farmers have been selected from Tanjung Karang to Sabak Bernam, where paddy cultivation is encouraging, especially in Selangor, Malaysia. Government agencies can then utilize the information from this research and local authorities to map out any suggestions to paddy farmers on the advantages of using drones in paddy farming. Other than that, the government also can find out ways to help the y farmers in terms of finances to buy more drones.

Keywords: *Agriculture Drone, Spraying, Paddy Fields, DJI Drone, Paddy Farmers*

1. INTRODUCTION

Agriculture is the world's main food source, and it has been dealing with significant difficulties due to rising food product demand, worries about food safety and security [1] and demands for environmental protection, water conservation, and sustainability [2]. The world population is forecast to reach 9.7 billion people by 2050. Therefore, this trend is expected to continue. It is anticipated that both food demand and water consumption will rise significantly in the near future, with agriculture serving as the most notable example of global water usage.

About 50% of the world's population eats rice as a staple, and 90% of the world's rice is produced in Asia, where rice cultivation is practiced. However, just 7% of the country's total rice production is exported. In light of this, rice and paddy are essential for many developing nations' efforts to ensure food security, preserve their sociocultural traditions, and engage in strategic interventions. Except for Australia, the United States of America, and several South American nations, most of the world's paddy fields are grown on a small scale. For this reason, paddy farming sustains the livelihood of millions of small-scale farmer families and landless agricultural laborers throughout Asia. Small-scale farming can be distinguished from Malaysia's paddy cultivation, conducted on moderately sized plots of less than two hectares [3,4] and involves about 194,000 farmers [5]. A small parcel of land causes low productivity and high production costs. This country is comparatively disadvantaged in achieving 100% self-sufficiency due to a lack of economies of scale (SSL).

Malaysia has eight main paddy granary areas, which can be considered the country's rice bowl and source of food security. The National Agricultural Policy (NAP) of 1984–1991 set aside designated wetland paddy areas when it established main granary areas. It can be seen as a strategic move to support the growth of the paddy and rice industries and safeguard the country's food security. While other small paddy fields are scattered throughout the country, paddy farmers have settled in these main granary areas [6]. Only several assistance programs are provided to the granary areas, which have reduced poverty and improved the livelihoods of paddy farmers. These regions' average yield per hectare for 2017 was 4.47 mt/ha, which was higher than the national average yield of 4.03 mt/ha. Four of eight granaries (MADA, KETARA, IADA Pulau Pinang, and Barat Laut Selangor) were comparatively more productive per hectare than the others. However, compared to other Southeast Asian nations that produce rice, these granaries' average production was third, after Vietnam and Indonesia. However, it is important to note that Malaysia's total paddy cropping area is the smallest in Southeast Asia at 0.70 million hectares. According to the United States Department of Agriculture (USDA), 2020, the top three rice producers in the region—Indonesia, Vietnam, and Thailand—have allotted 11.50, 7.54 and 10.83 million hectares, respectively.

In Malaysia, the agriculture industry is the most promising, but it is now facing a number of issues, one of which is the scarcity of manpower for farming. Extreme weather conditions, an inadequate supply and ineffective fertilizer application, infections, diseases, allergies, and other health issues brought on by chemical applications (fungicides, pesticides, insecticides, etc.) or insect or animal bites are additional issues or difficulties. Drones have shown to be one of the approaches that enable quick and non-destructive examination of the air quality, physical characteristics of the components of soil, or crop growth to address some of the difficulties faced in agriculture through the use of sustainable ICTs. Today's farmers face a wide range of complex circumstances that affect the profitability of their operations, from the availability of water to the many seasons of growth, wind, soil quality, the presence of weeds and insects, and more. As a result, farmers are turning to cutting-edge drone technology to help solve these issues quickly and effectively. Drones can gather information on various topics, including crop yields, livestock health, soil quality, nutrient measurements, weather patterns, and rainfall totals. The information obtained from this can then be used to map out any problems more precisely and to develop solutions based on solid evidence.

Future environmental concerns may also result from the increased use of pesticides and fertilizers in farming practices and the intensification of those practices. Similarly, to this, there is a global shortage of farmers and limited arable land. These difficulties highlight the requirement for creative and sustainable farming solutions [7,5,2,1]. A promising approach to solving these problems has been found to incorporate novel technologies. These discussions have led to the development of smart farming [8,9,10] and precision agriculture [11].

In this field, prominent technologies that have drawn researchers' attention include Wireless Sensor Networks (WSNs) [12,13], the Internet of Things (IoT) [14,15,16]], artificial intelligence (AI) techniques, including machine learning and deep learning [17,18,19] computing technologies [20,21,22] big data [14,23], and blockchain [24,25]. In addition to the technologies listed above, remote sensing has also been identified as a technical instrument with significant promise for enhancing precision and smart agriculture. Popular remote-sensing devices include satellites, human-piloted aeroplanes, and drones [26]. Unmanned aerial vehicles, or drones, are becoming common (UAVs).

Due to the accessibility and availability of lightweight microelectronics, the use of drones has significantly increased in the current era. The colloquial term for unmanned aerial vehicles, drones, is used [27]. Microdrones, or those

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measuring 30 cm*30 cm*30 cm, to mega drones, or those measuring 300 cm*300 cm*300 cm, can be used for commercial purposes [28]. Depending on the mission and application, the size and the avionic components required for that may vary.

Logistics, land surveying, construction, maintenance and demolition, mining, disaster management, surveillance, defense, healthcare, agriculture, firefighting, food delivery, forensics, offshore plants aerial inspections, railways, underwater observation, and marine archaeology are just a few of the industries where the drone has found useful.

Agriculture Drone: Various methods and materials to choose and build drones for purposes like crop monitoring and sprinkling system for agriculture applications are described [29]. Also, various hardware components could be used in such applications. [30] suggested that drones with IoT can be used for precision agriculture with ease and efficiency. [31] have identified the following drones to do agricultural chores in a precise manner that may boost production and produce the greatest crop quality: Agras MG-1- DJI, Lancaster 5 Precision Hawk, DJI Matrice 100, DJI T600 Inspire 1, EBEE SQ- SenseFly, and SOLO AGCO Edition are some of the available drones. For the crop study, it was advised to use a specialized camera (such as a mobile camera, IR, NIR, and hyperspectral) with a drone [32].

Therefore, this paper investigates the influence factors in utilizing drones among paddy farmers in Selangor, Malaysia. The outcome will change the paddy farmers' perspective toward drone usage. It is also an eye opener for the local authorities to help the paddy farmer regarding finances with the extensive literature survey of the paper and the interview conducted by the researcher.

2. LITERATURE REVIEW

2.1 Drone basic concept

The growing use of small, unmanned aerial vehicles (UAVs), sometimes known as drones, in agriculture is one of the most recent trends. Drones are remotely piloted aircraft that lack a human pilot. These can greatly enhance geographical data collection and support evidence-based planning in agriculture. These tools and technologies can offer useful information that can then be utilized to affect policies and decisions, despite certain inherent limits.

Drones are utilized in various industries, including agriculture, disaster management, and the military. A new revolution has begun due to the benefits that "an eye in the sky" offers when combined with analytical tools that can translate data and photos into useful information. However, the secret to the long-term adoption of these technologies is to give privacy, safety, and security issues top consideration.

Drones are expected to significantly shift how people cultivate crops over time. Precision agriculture can be carried out while tackling the water and food crises by relying on drone technology [33]. Managing a crop using big data and GPS is known as precision agriculture [34]. Using their capabilities, drones have recently assisted farmers in increasing crop productivity. For instance, drones can fly at 120 meters and capture, modify, and analyze each leaf on a corn plant. They can also collect data on soil water-holding capacity and variable-rate water application, providing agriculture intelligence to farmers and agricultural consultants [35]. The use of drones in agriculture is being developed to support both local and large farming enterprises.

2.2 Drone and agriculture

The use of drones in agriculture and farming is changing. Farms and agriculture businesses can increase crop yields, save time, and make decisions about land management that will boost long-term performance by integrating drone technology.

Today's farmers face a wide range of complex circumstances that affect the profitability of their operations, from the availability of water to the many seasons of growth, wind, soil quality, the presence of weeds and insects, and more. As a result, farmers are turning to cutting-edge drone technology to solve these issues quickly and effectively.

With the help of agricultural drones, farmers can access various data that will help them make better management choices, increase crop yields, and boost overall profitability. Drones can gather information on various topics, including crop yields, livestock health, soil quality, nutrient assessments, weather patterns, and rainfall totals. This information can then be utilized to map out any problems more precisely and develop remedies based on solid evidence. Agriculture has a history of adopting new technological innovations to streamline operations. The newest technology development that will assist agricultural firms in meeting the shifting and expanding demands of the future is the usage of drones in agriculture.

The UN tested drone use in several areas under its purview, from agricultural to humanitarian disasters. As an illustration, the World Food Programme (WFP) and the Belgian government have collaborated to use drones in humanitarian catastrophes. Testing this in the field during challenging humanitarian crises was crucial in determining the value of drones in facilitating quick data gathering with improved accuracy and offering a safer monitoring system. Google and FAO have teamed up to improve the effectiveness and accessibility of remote sensing data.

Making effective policies and interventions to meet the Sustainable Development Goals by 2030 requires access to high-quality data. Drones are increasingly used in agriculture, for example, in agricultural production, early warning systems, disaster risk reduction, forestry, fishing, and wildlife conservation.

2.3 Application of drones in agriculture

2.3.1 Soil and field analysis

Drones can assist in collecting relevant data at every step of the agricultural cycle. We can monitor possible soil quality, nutrient management, or soil dead zones by collecting 3D maps of the present soil. The conventional techniques involve manually collecting soil samples from arbitrary sites and determining the soil's water status, nutritional deficits, and insect infestation or using satellite remote sensing techniques [36]. Although ground-based or satellite photography is more useful for refining variable rate applications like nitrogen, phosphorus, and potassium, these techniques take a lot of time, money, and effort. UAVs with thermal imagers can be used to monitor the moisture content of the soil. Since a crop will never grow perfectly evenly, distributing fertiliser uniformly instead of deciding where to apply it and how much to use based on plant density and health can save money and prevent soil pollution. Anything that makes the Variable Rate Application process more precise saves money and boosts crop production. It is possible to determine the quantity and proportions of chemicals to be administered in a given field with the aid of drone-generated variable-rate application (VRA) maps [37]. The drone platform could represent a new paradigm for policymakers and management personnel when it comes to predicting crop yield and production or developing long-term strategies to deal with unfavourable circumstances. [38] Calculated a rice field's yield and total biomass using low-altitude remote sensing from an unmanned helicopter. It was discovered that for calculating yield and biomass as a function of nutrient status for rice, the LARS - UAV platform might replace satellite-based and expensive airborne remote sensing technologies. It is possible to build time-series crop yield maps that can be used with information on farm biophysical parameters, management approaches, and socioeconomic factors. By analysing the matrix, it would be feasible to identify the root causes of issues and present practical solutions for boosting agricultural productivity and the overall well-being of the farming community. Based on historical yield, pest, and climate data, statistical models for risk management can be derived from the gathered data. It could be a potent tool for planning post-harvest management methods and early identification, prediction, and warning of pest infestation. Farmers can use this information to determine the best practices for planting, crop management, soil management, and other activities. Continuous monitoring can aid in the more efficient management of crop nutrient levels and better utilization of water resources.

2.3.2 Seed planting

Despite being a more recent and less common technology, several businesses are testing drone planting. In essence, producers are experimenting with unique devices that can shoot seed pods into ready soil. Startup drone companies have played a key role in creating innovative drone technology to help with various ecological and agricultural problems. Consider Drone seed. The drone technology may be modified and deployed to various agricultural types, cutting labor expenses and overall planting timeframes.

2.3.3 Crop spraying and spot spraying

This is the most crucial step in the life cycle of a crop. For crops to continue producing high yields, constant fertilization and spraying are necessary. Historically, this was accomplished by hand, using cars, or even an aeroplane (in some parts of the world). These procedures can be exceedingly expensive in addition to being ineffective and onerous. Large reservoirs filled with insecticides, herbicides, or fertilizers can be fitted to drones. Crop spraying with drones is much safer and more economical. Even fully autonomous drone operations are possible, and they can be programmed to follow predetermined routes and schedules. Drones can execute more sophisticated, targeted, and accurate tasks than those mentioned above. Therefore their uses are not restricted to those mentioned. It can be used to apply protectants effectively. Drones can be employed for "search and destroy" pest management operations, which involve locating and eliminating particularly vexing insects. Canada used the first airborne pesticide spray to combat forest insect problems. They utilized calcium

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arsenate to stop the spruce budworm (Choristoneurafumiferana) from defoliating forest stands [39]. In 1980, the initial remote-controlled aerial spraying system was constructed. The RMAX, R50, KG-135, YH300, and YH3 from Yamaha were created for spraying pesticides on crop yields such as rice, soybeans, and wheat [40]. In order to prevent human sickness caused by insects, Miller (2005) presented an experiment to ascertain the efficacy of employing a UAV for pesticide dispersal. A series of studies were conducted to determine the efficiency of the UAV for aerial pesticide distribution, using a commercial off-the-shelf Yamaha RMAX type UAV equipped with both liquid and granular pesticide dispersal devices [41].

2.3.4 Crop mapping and surveying

Effective monitoring of vast crops and acreage areas is one of drone technology's major benefits. In the past, satellite or aircraft imaging was utilized to acquire a broad farm perspective and identify potential problems. However, in addition to being pricey, these photographs lacked the accuracy drones can deliver. Today, you can get real-time video and time-based animation showing crop development in real-time. Thanks to drone mapping and surveying, technology decisions can now be based on real-time data rather than old pictures or educated guesses. The presentation of crop information in GIS is enhanced by a three-dimensional (3D) depiction of a field scene, providing more data to help automate farming activities in agricultural fields [42]. High-definition, geographically precise 3D elevation models and maps of the fields may be created utilising the photos taken by the drones' high-resolution cameras and laser scanners. The collected photos are transformed into point clouds, which can then be used to construct maps [43,44]. These maps can be used to estimate volume, design irrigation and drainage systems, and apply chemicals. We can get data from agriculture drones such as general crop and plant health, land distribution based on crop type, crop life cycle, and accurate GPS maps. Drones can also be used to observe and examine animal activity and movement. A UAV can measure a cow's body temperature using temporal sensors to identify illness early on. They can also be used to monitor agricultural areas at night [45]. Drone survey images can be employed to build comprehensive maps of the forest cover and calculate tree height. They can also be used to locate and put out forest fires. Drones also make it easier to find and evaluate unlawful mining, fires, deforestation, and oil spills that endanger the livelihoods of forest populations. Without running the danger of immediately catching criminals, they can also spot camps and paths where trespassers, including unauthorised hunters, are present [46].

2.4 Requirements for agriculture drones

A 10 to 15-liter spraying tank with excellent spraying efficiency is needed for fertilizer. The drone's body must be both strong and flexible in all motions. For even distribution and thorough coverage, eight spray nozzles would be necessary. The nozzle's intended flow rate should be between 4 and 8 L per minute. The spray must ensure intense penetration and superior drift prevention. Given that the downwash from the thrusters will further boost the flow velocity of the spray, these eight nozzles might be positioned beneath the eight thrusters themselves. Eight separate sets of solenoid valves are used for spraying and independent variable frequency control.

For the powerful spraying ability, the agriculture drone does require a horizontally opposed six-cylinder double plunger pump. About 8 meters would be the spray's breadth. The agricultural drone should be capable of spraying 10 Acres in an hour while keeping these design specifications in mind. To become a next-generation drone, the drone could have additional characteristics, including a radar system, an obstacle avoidance system, and a camera system. A spherical radar system would be the best option for the radar because it can detect barriers and everything around it in any kind of environment and has advanced viewing angles for interference from light or dust.

Obstacle avoidance systems and adaptive flight features should be automatic to protect drones from collisions and object hits. Dual front pilot view (FPV) cameras are suitable for increased awareness. These fitted FPV cameras would offer sharp views both front and back. The benefit of maintaining both forward and backward motion is that the drone will not need to make yaw motions to get a complete picture of its surroundings. For the drone to perform better during nighttime operations, the camera should be accompanied by searchlights. For this operation, a battery with a capacity of about 25000mAh and at least 1000 flight cycles is needed. With no external cooling system, the charging should be instant. The battery must have circuit board potting, corrosion-preventive coatings, and water resistance. The batteries would need to be charged at a battery station. It should have a charging capacity of at least 6800 W and charge the battery in 10 minutes [47].

2.5 DJI Drone T30

When the survey was conducted in the area of Tanjung Karang to Sungai Besar, almost all the paddy farmers were using DJI drones. This is because DJI drones are very suitable for handling the work of spraying pesticides in paddy fields, it meets all the characteristics that can make the farmer's work easier. The more specific type of drone that is being used is AGRAS T30. This is due to the fact that size does important when addressing the difficulties presented by modern farming. The T30 is an amazing piece of agricultural ingenuity, weighing in at 24.6 kg, measuring almost 3 meters broad, and having a maximum takeoff weight of 76.5 kg.

The AGRAS T30 has a spherical omnidirectional radar that supports obstacle avoidance in the horizontal and overhead directions, terrain adaptation, and altitude maintenance in addition to its size and cargo capacity. The T30's spraying system is made to distribute agrochemicals more quickly and accurately. With a 16-nozzle design and a flow rate of up to 8 liters per minute, the T30's speed and agility are combined.

Farmers can use spraying drones, which are effective instruments for automating and accelerating laborious procedures. The outcome of this fundamental feature is a game-changer for agriculture's future. Important elements of precision farming can now be carried out continuously thanks to technology.

Although laws have been reluctant to keep up with technological advancements, the hardware is ready. The brand-new DJI AGRAS T30 is a prime example. It can operate continuously thanks to its clever batteries, which can be fully charged in 10 minutes. Spraying drones can assist farmers in working more intelligently, quickly, and precisely than ever before when combined with insights produced by equipment like the P4 Multispectral.

The Agras T30 is a remarkable machine that follows the DJI Agras MG 1 and Agras T16 as its forerunners. With a 30L operation tank that can spray up to 8 liters per minute and 16 spray nozzles that can spray up to 9 meters, this machine can cover 16 hectares in just 60 minutes. It sets a new standard for drone technology used for crop spraying. The Agras T30 has an orchid configuration that is useful for operations other than the usual rice, maize, and sugarcane fields. It can now help in orchid fields with insecticides and even tree distribution.

In order to provide operators with a 3D model of the orchid and help them map out an exact flight path, the Agras T30 interfaces with the DJI Phantom 4 RTK. By using controlled systems to carry out the operation safely, a pilot error can be eliminated if the right data is provided and the appropriate training is used. This model is a waterproof aircraft with an IP67 resistance rating against dust and water, which helps with over-water operations spraying plants like hyacinth.

PFV cameras on the front and back provide a 360-degree picture of the operation to the pilot. The Agras T30, like the older T16, has a spherical radar system to help in following difficult terrain and omnidirectional obstacle avoidance to aid with autonomous detours.

Based on the literature discussion above, it can be seen that there are many advantages of drones for paddy farmers. Much past research has focused on agriculture in general, drones' services, and application in oil palm [48], studies on the function of the usage of drones [49], effective use of the drone [50], anyhow, none of the studies is looking at the factors contributes to the drone usage among paddy farmers, which the outcome is crucial to change the paddy farmers perspective to encourage use the drones in their farming activities. Moreover, this paper highlights the opinion of paddy farmers on what motivates them to use drones. It is hypothesized that paddy farmers use drones to reduce manpower, avoid health risks, to get data accuracy during fertilizing and farming activities.

3. METHODOLOGY

To obtain the final outcome of the paper, the research has conducted ten separate interviews with paddy farmers in Selangor, specifically between Tanjung Karang and Sungai Besar. The interview was done for more than two hours and two times with each farmer who bought or owned DJI Drones. All the interviews with farmers were conducted by the researcher using structured protocols. All the farmers in this research will be known as participant '1' until participant '10'.

4. FINDINGS

4.1 Time and cost savings

The fact that various chores may be completed in less time, thanks to smart technology, is one of the primary advantages for farmers. For tasks like mapping, surveillance, and crop spraying, drones outperform manned aircraft by a wide margin in terms of time efficiency. Additionally, seeds can be planted, and crops can be sprayed with water, fertilizer, insecticides, and herbicides using drones. Since many of these tasks can be completed using intelligent flying modes, farmers can spend less money on manpower and equipment because less time is spent in the field.

As mentioned by participant 2, "*before this, when using a blower, it would take about 50 minutes to one hour and a half for a piece (3 acres), now using a drone only takes about 20 minutes*". This is also supported by participants 1,3,4,6 and 7, who stated that "*using a blower usually takes about one hour to one hour and a half, but using a drone saves much time because it only takes 20 to 30 minutes a piece*". Participants 2,8,9 and 10 stated, "*when using drones to spray pesticides, it only takes around 10 to 15 minutes*". This is because they are already skilled in controlling their drones. As supported by [51], pesticides are sprayed using drones to stop the spread of agricultural diseases, so in about 30 minutes or less, a drone may spray herbicides and insecticides on a field. Generally, when using a drone, the time that can be saved can reach up to 40 to 45 minutes for a piece of rice field.

There are many cost savings when using drones, especially in the use of water, pesticides and insecticides. As mentioned by all participants, "*a piece of rice field usually uses 145 liters of water and 500 ml of poison when using a blower, but using a drone, only uses 45 liters of water and 60 ml of poison*". This shows significant savings due to the drone's more effective and even spray. Compared to using a blower uses a lot of water and pesticides because, as mentioned by participants 2, 5 and 6, "*Using a blower costs many waters and pesticides due to the slow movement of a man and the way the spray that is zig-zag*". One of the most valuable commodities in the agriculture industry is water for irrigation. Drone use in irrigation systems can also ensure efficient water distribution in rural areas with minimal water waste. Additionally, it can pinpoint the factors that lead to water waste [52].

4.2 Safer way to spray the crop

Farmers will always have to deal with pests and plant diseases, and physically applying chemicals to crops is time-consuming, labor-intensive, and unhealthy. Using drones to treat sick plants is considerably safer and more effective than physical labor and using land-based machinery. Smart drones also have autonomous flight modes, allowing farmers to plan flight paths exclusively around the fields that require treatment while leaving the healthier portions of the field chemical-free. Farmers will save money by not treating plants that don't require it, making this method of crop treatment safer overall.

In Malaysia, the problem farmers face are BLB (bacterial leaf blight). This disease is caused by Xanthomonas oryzae PV. These illnesses have a significant impact on rice output worldwide. Bacterial leaf blight, often known as Xanthomonas oryzae pv oryzae (Xoo), is a fatal disease that affects rice (BLB). 42 R genes now provide protection for rice, and this number is growing. Due to the co-evolution and selection pressure between Xoo and rice, certain Xoo strains or races, which are collections of strains that share incompatibility with designated sets of R genes, are selectively resistant to these R genes [53] Oryzae is thought to be the most significant and ancient disease affecting rice [54]. Japanese farmers discovered this illness for the first time in 1884. [55]. In Peninsular Malaysia, the infection was first detected on a modest scale in the early 1980s in rice fields. In the past, this disease spread more quickly, resulting in 10–20% crop losses under mild prevailing conditions, while up to 50% were documented under favorable conditions.

In Peninsular Malaysia's 12,080-hectare rice-growing regions, such as Selangor (5,945 ha), Kedah (4,415 ha), Pulau Pinang (620 ha), Terengganu (440 ha), Negeri Sembilan (291 ha), Perak (174 ha), Pahang (46 ha), Perlis (141 ha), Johor (5 ha), Kelantan (1 ha), and Melaka (less than 1 ha), an increase in bacterial leaf blight attacks [56]. BLB causes moderate to severe infection and nearly encroaches on Malaysia's most important rice-growing regions. This might cause the field's entire crop to collapse. The condition may be seen in all phases of the plant, including the seedling, vegetative growth, and reproductive stages, as the disease is a vascular ailment. The disease can spread swiftly through the movement of plant straw, rain, hail, wild rice, wind, weeds, irrigation water, and seeds [57]. Bacterial inoculum enters host plants by wounds, lesions, or water openings in the leaf, then progressing through the plant's xylem one layer at a time [58].

As mentioned by all participants, "*the spread of BLB is through humans who pass through rice fields*". Most likely to those who still use blowers to spray pesticides, and when drones were first introduced and used in the area, it has become an effective solution for rice farmers. As mentioned by participant 2, "*It is easy to use drones. BLB diseases do not stick to our bodies*". Participants 6 and 7 said, "*when we use drones, we do not have to enter rice fields where there is BLB disease, so the disease will not spread to other areas"*. Another participant mentioned that "*rice farmers do enter not only their own rice fields but also have work in other rice fields. So, you have to go in to spray pesticides, that is, if you use a blower. since using drones, rice farmers do not have to enter rice fields anymore, so indirectly, we can control the spread of this BLB disease"*.

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Interestingly, this disease does not harm humans, it only affects rice plants. As mentioned by 5 and 6, "*As far as we enter and passed rice fields with BLB disease, there was no effect on us. No pain or fever*". Other participants also said, "*BLB disease does not affect farmers, only paddy plant*".

Lastly, by using drones, paddy farmers can be spared from the long-term effects of pesticide spraying due to using blowers. This is mentioned by participants 5,6 and 10 "*Feel a little safer when using a drone because we can spray from afar. If we use a blower to some extent, we will be exposed to pesticides even though we have used all kinds of safety equipment".* Other participants said, *"When pesticide exposure, the effect is not short-term but long-term. There are cases of rice farmers who are old, they started to have the effects of hemorrhagic cough and asthma.* This shows that the presence of drones is very suitable for dealing with BLB disease.

4.3 Fast data acquisition for accurate crop analysis

Drones can assist farmers and agronomists in building highly precise maps and 3D models of the region using a technique called drone photogrammetry. A topographical map of the farmland can be created using drone mapping software like Pix4DFields or Drone Deploy by stitching together drone images. Drones can be equipped with various cameras, including RGB, multispectral, and thermal cameras, giving farmers access to many data types.

As mentioned by participant 5, "*The old version of the drone is complicated to operate because there is no auto setting map, the controller is only manual. You need two people to operate the drone so that the drone does not crash. However, the new version drone is easy to operate because there is an auto setting map where we can pinpoint from the area a to b*". For Participants 2 and 10 said, "*The use of this auto setting map is easy because the drone has done mapping and is stored in the system, so in the future, if we want to spray in the same place, the drone will move by itself, we just control the up and down of the drone and left and right only".* Furthermore, participants 5 and 6 said, "*It is easy to see the state or condition of the rice paddies. We do not have to go down and see for ourselves".* Participant 3 said, "*I have sprayed pesticides in other fields as well, not only rice fields. So, suppose it is like a palm plantation. In that case, it is easy for us to monitor the situation happening in the palm plantation".* Besides that, he also added, "*if we do many jobs in other places, at first it is a little difficult because we want to map that area first, after that it is easy".*

Participant 8 said, "*when I have auto setting map and camera, I can spray pesticides at night. I have done it; it is quite difficult, there are many challenges, but it can be done if you are brave and skilled at operating a drone".* While rest of the participants said, "*Auto setting map helps a lot because it can pinpoint area 'A' to 'B'. So I do not have to struggle to operate the drone in the future. Very helpful for those still not fully proficient in using drones".*

Farmers can make the required adjustments thanks to the data from these maps to keep the land fruitful and healthy. Since drones are simple to use, farmers may collect field data as frequently as they would like, enabling them to see issues as soon as they arise and take appropriate action.

5. CONCLUSION AND RECOMMENDATION

The incredible advancement of drone technology continues to profoundly impact all facets of contemporary life, revolutionizing our personal lives and how we conduct business. Drone technology appears to have been warmly welcomed by the agricultural sector, which is now deploying these cutting-edge tools to revolutionize modern farming. Farmers and the drone pilots who fly them can make some parts of the farming process more efficient using high-tech drones. Drones benefit various operations, including agricultural monitoring, planting, livestock management, crop spraying, irrigation mapping, etc.

Drones are useful for paddy farming in terms of monitoring, measuring, and taking decisions based on current crop and livestock data. Eliminating the need for guesswork in modern farming enables farmers to maximize their paddy fields, manage their businesses more effectively, and increase crop production.

Drone technology has more to offer regarding features, capabilities, and facilities, all of which have the potential to bring about substantial technological advancements, particularly in applications related to agriculture, with the goal that this paper will awaken the eyes of other researchers, paddy farmers, local authorities and other people to encourage and motivate the agriculture, especially in the paddy plantation to utilize the advantages of the drone to boost the paddy production in the future.

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