

FARMERS' PERCEPTION TOWARDS THE EFFECTIVE USE OF DRONES IN SELECTED RICE FARMING AREAS IN MALAYSIA

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ABSTRACT

The Revolution Technologies of IR 4.0 especially the use of drones in the agriculture sector showed the era of digitalization in Malaysia is to expand. The use of drones is an increasing trend, and it might contribute to overcoming the challenges related to the sustainability of rice production and food security. However, there are still doubts among farmers about the effectiveness and efficiency of drones in rice cultivation, especially in spraying activities. Therefore, this study aims to evaluate the effectiveness of drones in rice cultivation from the farmers' perspective. Data was collected from 201 total of respondents in Barat Laut Selangor Integrated Agricultural Development Areas (IADA BLS) and Muda Agricultural Development Authority (MADA). The results showed that most of the respondents used drones in activities such as seeding, and pesticide and fertilizer spraying. Most of the respondents (98%) are willing to substitute drones as an alternative to labour. About 72% of farmers believe that the efficiency is increasing in field management, 69.2% said that drones can save time in spraying, 58.2% said that the effectiveness of pesticide use increased, and 37.8% said that seed distribution was more effective as compared to conventional practices. The cost of labour stated a decreasing value for both MADA and IADA BLS at approximately RM49.15/and RM78/ha respectively. The use of drones for spraying activities could 52.5% of time-saving. In conclusion, a good framework for a win-win situation between farmers and private entities might boost the use of technology, especially drones for the long-term benefits.

Keywords: Drone technology revolution, rice farming, effectiveness, cost and time-saving

INTRODUCTION

The technological revolution of Industry 4.0 (IR4.0) especially the use of drones in the agriculture sector showed the expansion era of digitalization in Malaysia. It might contribute to the role of addressing the challenges related to the sustainability of rice production and food security. The rice industry is an important crop that received special attention from the government. However, rice productivity is still low compared to other ASEAN countries. In 2021, Malaysia's average yield for rice is at 3.7 tons per hectare with total production at 2.4 million metric tons (KPKM, 2022). Meanwhile, the self-sufficiency level (SSL) for 2021 was at 65% which shows the decreasing trends from 2016. Malaysia has targeted SSL at 75% by 2025 and 80% by 2030 (DAN 2.0, 2021-2030). To achieve that goal, the development of the rice sector needs to be led by the application of modern technology to increase productivity along with the development of IR4.0.

The use of drones was shown to be an increasing trend. It is seen as a game-changer, offering farmers innovative tools to increase productivity, reduce costs and time in the fields, and overcome labor shortages. Drones are mostly provided by the service provider to the farmers in selected activities such as spraying fertilizers, pesticides, and herbicides as well as seed cultivation. Spraying operations in paddy fields are considered the most dangerous operations because operators must deal with toxic chemicals and prolonged and frequent exposure. Drones provide an effective method for such operations by reducing the operation time by at least about a third compared to conventional (Norsida, et al., 2019). Muazu et al. (2015) reported that both fertilization and pesticide spraying operations constituted about 63.42% of the total cost expenditure in North Selangor (i.e. 36.78% in fertilization and 26.64% in pesticide spraying).

The price of pesticides showed an increasing trend as well as the cost of labor. Hence, there is a need to find a more effective method that is more efficient and cost-saving. As such, an alternative like the drone was used for spraying either pesticide or fertilizer. The drone is designed to fly at a low altitude of several meters so that the spray effect can be controlled in the active

area (Huang et al., 2009). The effectiveness of drones in pesticide spraying in rice production operations is yet to be confirmed and requires further research (Norsida et al., 2019). However, there are still doubts among farmers about the effectiveness and efficiency of drones in rice cultivation, especially in spraying activities. Therefore, this study aims to evaluate the effectiveness of drones in rice cultivation from the farmers' perspective.

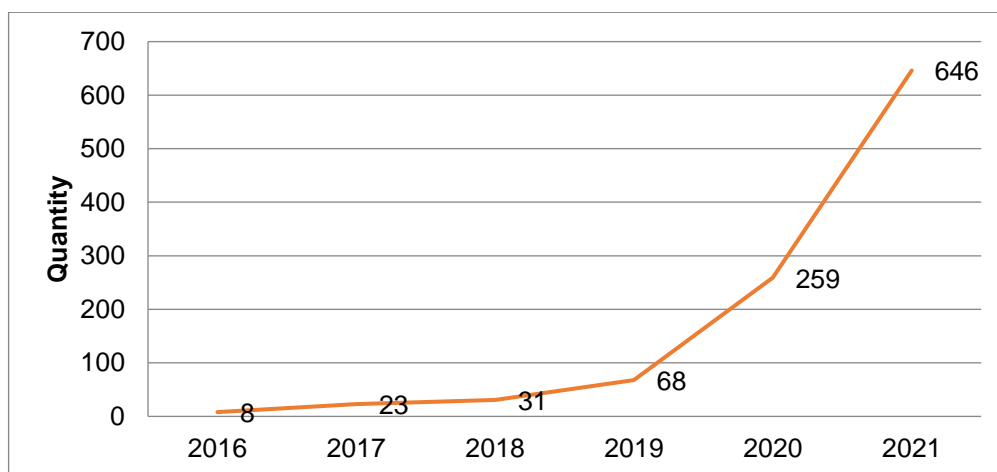
Current Status of Drone Applications in Rice Farming

Drones in Malaysia are applied in different disciplines, including agriculture, mapping, forestry, river monitoring, transportation, construction, coastal management, flood management, and other applications. Among these, agriculture and mapping are the main application areas (Gohari, A., 2023). Recently, the use of drones in agriculture has become increasingly popular among farmers globally. Drones or unmanned aerial vehicles (UAVs) have become an important tool for smart farming or precision farming. Drones' technology has been capable of efficiently and effectively expediting the process of operations in the field (Azizul et. al., 2023). The use of drones in Malaysian agriculture is relatively new, but the global use of drones in agriculture has increased significantly in the past 10 years and is likely to continue growing in the near future.

The drone market in Malaysia presents a dynamic landscape with anticipated steady growth. The increasing demand and adoption of drones in Malaysia across various sectors. The use of drones in Malaysia was started in 2016. Data from industry players in drone technologies shows that the number of drones drastically increased from 2016 at eight (8) only to 646 in 2021 (Figure 1). In the agriculture sector, the use of drones was focused on crop maintenance activities for palm oil, coconut, pineapple, rice, fruits, especially durian and vegetables. In Malaysia, drone technology for agriculture is mainly employed in the private sector.

Although the drone industry has established a broad niche of application in agriculture, the impact on Malaysian rice farmers is relatively minimal at engagement in sprayer drones solely (Dorairaj and Govender, 2023). Sprayer drones are used to facilitate the timely application of fertilizer, and pesticides and also for seed sowing. The application of drone in farmers' community particularly is not done by themselves. In rice farming, the application of drones was operated by service providers and government agencies in the pilot project. Several companies have provided spraying services using drones in rice farming across Malaysia and the numbers are increasing. Now, the use of drones is becoming more widespread in 12 granaries areas in Malaysia.

Figure 1: The Total of Drones Sales from 2016-2021



Source: Sanyeong.Sdn.Bhd.
Note: Data for 2021 until Mac only.

The application of drones involves changing agricultural practices from conventional spraying methods to more accurate and advanced methods through drone spraying. Traditional methods are seen as inefficient for the surveillance of disease and plant pests. The method of sowing seeds, fertilizers and chemical spraying using drones is expected to reduce labor for each activity. This shows that there is potential for the use of drones as a substitute for labor and can overcome the problem of labor shortage in the agricultural sector. Besides that, the application of drones to being able to provide uniformity and more efficiency and avoid farmers' health problems caused by the use of chemicals during spraying.

Daily, an average 20-liter capacity drone could cover up to 10 hectares of paddy field per day. It is estimated that the entire area of IADA Barat Laut Selangor (IADA BLS) is in 100 drones to meet the demand of farmers. Every time a spraying activity is carried out, it requires as many as 2 workers to operate the drone, namely a pilot and a co-pilot. The charges are based on spraying activities and area at RM42 to RM69.40 (USD8.86–14.70) per hectare (based on a survey with the service provider in IADA BLS).

The potential operation of UAVs in the agricultural sector in Malaysia has forced the Civil Aviation Authority of Malaysia (CAAM) with the powers granted in the Civil Aviation Act 1969, to issue the first directive specifically designed for UAVs in agriculture (Onn and Md. Tahir, 2022). In 2021, around 57 areas were announced as a free-flying zone for UAVs in agriculture and research and development (R&D) with the main objective being to maintain safety in the operation of UAVs. The introduction of

the CAAM directive on agriculture shows the government's commitment to ensure the operation of UAVs in agriculture. However, there is a list of pesticides and any other substances permitted by the Department of Agriculture (DOA), Malaysia to be used for spraying drone operations.

The use of drones for crop maintenance has great potential because this technology is growing and the cost of a drone unit is also decreasing trend because of increasing in drone suppliers and models. In addition, the use of this technology can also attract the interest of the younger generation to venture into agriculture. Since drone technology is gaining attention, paving new directions in modern rice farming, more youngers are pursuing technical courses which are readily available locally. Further, drone technology will boost the rice industry and improve the farmer's livelihood. Hence, the rice industry is more attractive and encourages the young generation to enter this industry to increase productivity and sustainability.

LITERATURE REVIEW

The use of drones in agriculture has been reviewed by many researchers in multiple disciplines literature in local and international. Technology innovation and farmer perceptions play crucial roles in shaping the future of sustainable farming practices. Farmers' attitudes regarding new technology may be a crucial component in explaining farmers' adoption of new agricultural techniques (Kamarul Zaman et al., 2023). Attitude is a fundamental, inherent concept in social psychology that has been extensively employed in the study of human behaviour (Adnan et al., 2019, Edison et al., 2003). Attitudes, as a notion, help to assess whether an item or activity is good or unpleasant. Theory of Planned Behavior which states that attitudes, as a concept, aid in determining whether an object or activity is pleasant or not. Farmers' perceptions of and attitudes toward modern technology are important to influence their decision whether willing to accept or not.

A study by Noor. & Noel, (2023) show that labor factors are the most crucial for adopting drones and the problem of water scarcity could be easily overcome and time effectiveness to hold the third factor. Huang et al., (2009) stated that there are potential benefits to drone usage in agriculture that include large area coverage, fewer quantities of pesticides, labour savings, quick response time, and timely operation well before pest occurrence exceeds economic threshold levels. Liu et al. (2018), has found that using a drone for pesticide spraying resulted in a 30% reduction in pesticide use and a 90% reduction in labor compared to manual spraying. Candiago et al. (2015), similarly found that using a drone for pesticide spraying resulted in a 40% reduction in time and a 30% reduction in pesticide use compared to conventional spraying.

Numerous researchers have attempted to investigate the role of drones on the cost and time management of the farmers and most of the researchers highlighted their important role in saving the time and cost of the farmers (Rajput et al., 2021, Pathak et al., 2020, Muraru et al., 2019). Research in India stated that drone usage saves 20 times of farmers and the cost effective was depending on drone model (Rajput et al. (2021). Rosedi et al. (2022), concluded that the use of drones in chemical spraying saved time and made the spraying process faster and also increases the yield. Drones' method is mostly labour-effective, time-saving, and water-saving compared to traditional methods (Noor. & Noel, (2023). A study by Niyom et al., (2022) using a structural model indicates that there exists a positive relationship between drone usage and cost and time management of Malaysian farmers.

In summary, much of the past literature has discussed the benefits of using drones in agriculture and rice farming. The willingness to accept drone technology among farmers depends on their perception and attitude toward the effectiveness and efficiency of drone compared to traditional methods.

MATERIALS AND METHODS

Data was collected from farmers in selected granary areas, that are Barat Laut Selangor Integrated Agricultural Development Areas (IADA BLS) and Muda Agricultural Development Authority (MADA). Respondents were selected using a stratified random sampling method covering every district and block in these two granary areas. A total of 201 respondents were selected in the field survey involving two farmer groups using the drone and conventional methods. The survey with the farmers was done using a structured questionnaire and collecting the information through a face-to-face interview. The first section gathered information on rice farmers' characteristics and demographic background, while the second section collected cost and return data associated with rice production during the Main Season 2021/2022 cropping season.

Descriptive statistics and cost analysis were used for data analysis. The descriptive analysis has been done using the SPSS 22.0 software as a method to present demographic data of respondents and farmers' perceptions on the effective use of drones in rice farming. Besides that, cost analysis is a type of economic analysis that considers costs explicitly incurred by farmers for every activity such as seeding, fertilizer and pesticide spraying for both practices. The calculation has been done using Excel software to get wage differences between drone applications and conventional. Cost comparison analysis is a type of cost analysis method, by considers the costs of using drones and conventional methods. Cost comparison analysis can show which one method can save the farmers money. Further, time comparison analysis also has been done to get the time-saving using drones compared to the conventional method.

RESULTS AND DISCUSSION

A survey was conducted on a rice farm involving 201 respondents consisting of 50.2% of respondents in the MADA area and 49.8% in the IADA BLS area. The findings of the study show that most of the respondents are Malay, and 98.5% were male respondents. Most of the respondents were between the ages of 41 and 60 (25.9%). The majority of the respondents (52.7%) had a secondary education level however, there are 4% of the respondents had a degree and are involved in rice cultivation. Most

(62.7%) respondents have 4 to 6 family members and 51.7% of respondents have less than 4 dependents. The majority (86.6%) of respondents are rice growers as their main occupation and 34.8% of respondents have less than 10 years of experience in rice cultivation. A total of 37.8% of respondents have at least one family member involved in rice cultivation (Table 1).

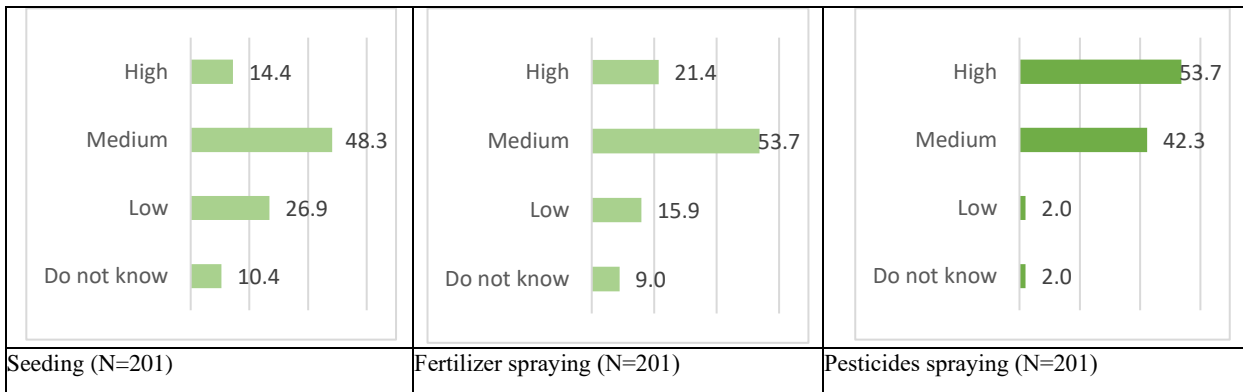
Table 1: Demography Profile of Respondents in MADA and IADA BLS

	Parameter	N	%
Granary areas	MADA	101	50.2
	IADA BLS	100	49.8
Age	<31 years	29	14.4
	31 - 40 years	33	16.4
	41 - 50 years	52	25.9
	51 - 60 years	52	25.9
	> 60 years	33	16.4
Gender	Male	198	98.5
	Female	3	1.5
Race	Malay	201	100.0
Education	Primary school	21	10.4
	SPR/PMR	38	18.9
	SPM	106	52.7
	Diploma/STPM	23	11.4
	Degree and above	8	4.0
	Others	3	1.5
Family members	< 4 persons	27	13.4
	4 – 6 persons	126	62.7
	7 – 9 persons	44	21.9
	>10 persons	4	2.0
No. of dependents	<4 persons	104	51.7
	4 – 6 persons	87	43.3
	7 – 9 persons	9	4.5
	>10 persons	1	0.5
Main occupation	Rice farmers	174	86.6
	Others farmer	1	0.5
	Business	1	0.5
	Government servant	14	7.0
	Private	10	5.0
	Others	1	0.5
Experiences	< 10 years	70	34.8
	11 - 20 years	56	27.9
	21 - 30 years	44	21.9
	31 - 40 years	23	11.4
	> 40 years	8	4.0
Family labour	None	54	26.9
	1 person	76	37.8
	2 persons	42	20.9
	3 persons	20	10.0
	4 persons	6	3.0
	5 persons	2	1.0
	6 persons	1	0.5

Source: Field Survey Data 2022

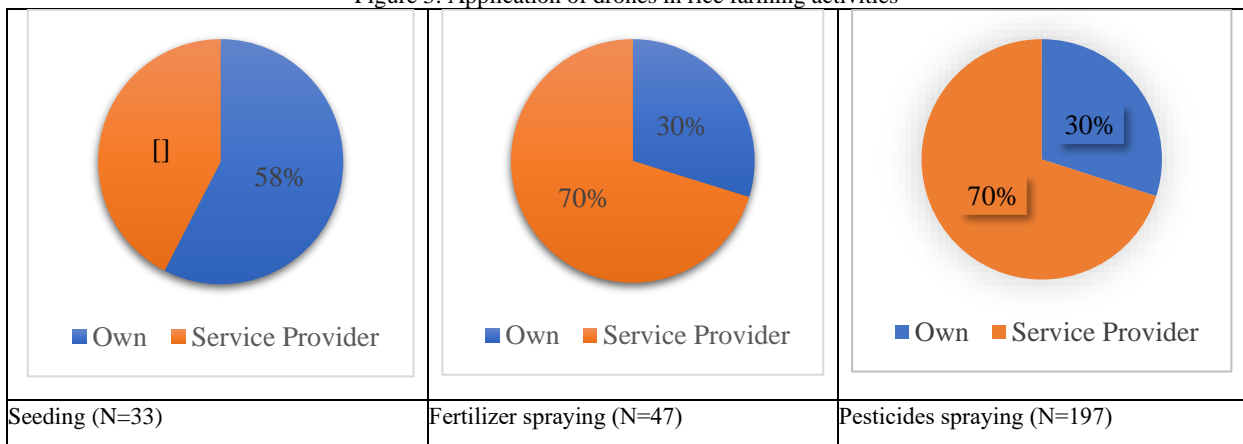
Figure 2 shows the farmers' level of knowledge of drone application in rice farming activities. The majority of respondents (53.7%) are familiar with pesticide spraying and have average knowledge of fertilizer spraying (53.7%) and seeding (48.3%). The results showed that most of the respondents (70%) used drones in activities such as pesticide and fertilizer spraying using a service provider. Meanwhile, 58% use their drone for seeding activity. (Figure 3). Most of the respondents (98%) are interested in using drones and willing to substitute the use of drones against labor (Figure 4).

Figure 2: Farmers' level of knowledge on drone application in rice farming activities



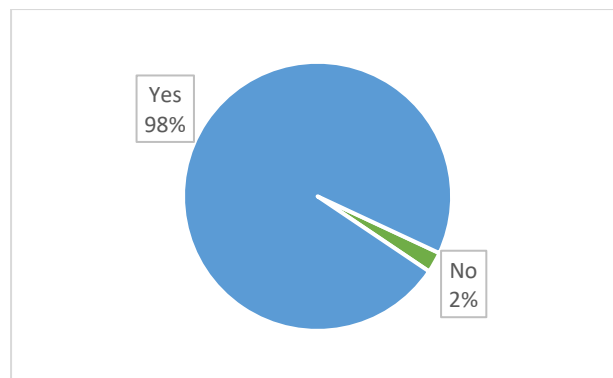
Source: Field Survey data, 2022

Figure 3: Application of drones in rice farming activities



Source: Field Survey data, 2022

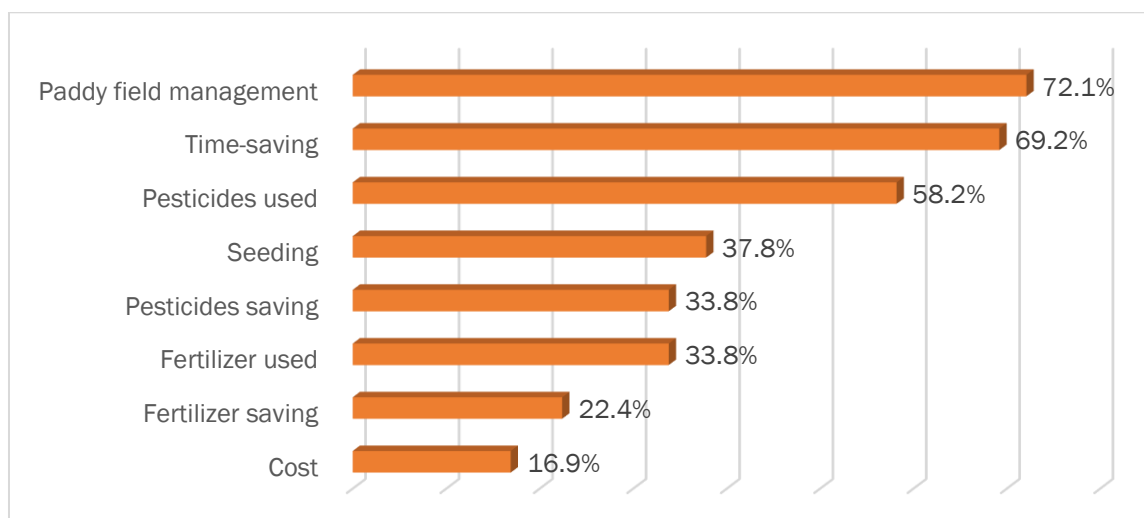
Figure 4: Farmer's willingness to accept the application of drones as a labor alternative



Source: Field Survey data, 2022

Figure 5 shows the effectiveness of the application of drones in rice farming activity. About 72% of farmers believe that their efficiency in field management has increased while using drones. This finding has related to study by Noor. & Noel, (2023) stated that the majority of rice farmers in Haryana District, India prioritises labour effectiveness while considering whether to utilise drones for pesticide application. In addition, 69.2% said that drones can save time in spraying, 58.2% said that the effectiveness of pesticide use increased, and 37.8% said that seed distribution was more effective as compared to conventional practices. There are many cost savings when using drones, especially in the use of water, pesticides and insecticides (Shahibi, et al., 2023). However, in terms of wage costs, production costs, and the use of fertilizers and pesticides, there is no change. Meanwhile, study by Noor. & Noel, (2023), stated that the majority of rice farmers in Haryana District, India prioritises labour effectiveness while considering whether to utilise drones for pesticide application.

Figure 5: Perceptions towards the effectiveness of the application of drones in rice farming



Source: Field Survey data, 2022

The survey shows that there is a difference in the cost of using drones compared to conventional practices (Table 2). The cost for seedings using drones is RM69.40/ha lower than the conventional labor cost which is RM86.75 for the MADA area. Meanwhile, for fertilizer, the cost of spraying using drones is RM69.40 compared to conventional at RM80.00/ha. However, the cost for pesticide spraying is the same for both practices, which is RM69.40/ha. In total, there is a cost-saving while using drones compared to conventional practices which is RM49.15/ha. In addition, the use of drones is not just saving labor costs, it also saves time for each activity of seedings, fertilizer and pesticide spraying compared to conventional practices. As for all the practice of using drones, it takes 15 minutes compared to the conventional that takes 1 hour for one hectare of rice fields. The use of drones can save time for three activities as shown in the table below by 52.5%. Meanwhile, in IADA BLS the cost of using drones is lower than conventional for fertilizer and pesticide spraying activities at approximately RM78.00/ha and RM42/ha respectively. The use of drones for spraying activities in IADA BLS will also save 52.5% of the time. This finding is parallel with a study by Noor. & Noel in 2023 time taken to spray via drone only took 5-7 minutes per acre while via labour about 35 minutes per acre when 3-4 labourers were hired compared to traditional methods.

Table 2: Cost and Time-saving per ha by Activity in MADA dan IADA BLS

No	Activity	MADA				IADA BLS			
		Total Cost (RM/ha)		Time minutes/ha		Total Cost (RM/ha)		Time minutes/ha	
		Drone	Conventional	Drone	Conventional	Drone	Conventional	Drone	Conventional
1	Seedings (1x)	RM69.40	RM86.75	15	60	RM60.00	RM60.00	15	60
2	Fertilizer spraying (3x)	RM208.20	RM240.00	90	180	RM150.00	RM180.00	90	180
3	Pesticides spraying (6x)	RM416.40	RM416.40	180	360	RM252.00	RM300.00	180	360
Total		RM694.00	RM743.15	285	600	RM462.00	RM540.00	285	600

Sumber: Field Data Survey 2022.

CONCLUSION

The application of drones in rice fields has proven to save cost and time as compared to conventional practices. Some factors hindered the wide-spreading application of drones such as ageing farmers, lack of capital and knowledge as well as fewer numbers of drone service providers. A limited number of farmers are willing to invest in drone technology since the initial capital is quite high. In addition, the lack of incentives given to farmers to encourage the use of IR4.0 technology becomes a constraint for the acquisition of technology such as drones from abroad. A win-win strategy between farmers and private entities must be formulated to boost the use of technology, especially drones for the long-term benefits.

Acknowledgement

Thanks and appreciation to the director of the ES centre and Project leader for funding as well as cooperation among the team members. This finding is part of the Feasibility Study of Agricultural Input Development (KRE-260).

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