Information Management and Business Review (ISSN 2220-3796)
Vol. 16, No. 4(S), pp. 394-400, 2024

Smart Farming: Challenges and Adoption Factors among Paddy Farmers in IADA Barat Laut, Selangor

Abdul Rahman Saili[1], *Nur Badriyah Kamarul Zaman[2], Wan Noranida Wan Mohd Noor[2], Fazleen Abdul Fatah[2], Farah Adila Abdullah[2]
[1]Faculty of Plantation & Agrotechnology, Universiti Teknologi MARA, Sarawak Branch, Kota Samarahan Campus, Kota Samarahan, Sarawak, Malaysia
[2]Faculty of Plantation & Agrotechnology, Universiti Teknologi MARA, Melaka Branch, Jasin Campus, Merlimau, Melaka, Malaysia
arsaili@uitm.edu.my, *badriyah@uitm.edu.my, , noranida_mn@uitm.edu.my, fazleen5201@uitm.edu.my, farahadilaabdullah@uitm.edu.my
Corresponding Author: Nur Badriyah Kamarul Zaman

Abstract: Enhancing farm production through smart farming technology is crucial for addressing the challenges of achieving food security and improving the well-being of farmers. Aligned with Sustainable Development Goal 2 (SDG2), which is intended to tackle food insecurity and malnutrition while improving livelihood, smart farming integrates technologies such as IoT, drones, and artificial intelligence into agricultural practices. This innovation optimizes input like water, fertilizer, and pesticide, reduces operation costs, and increases productivity and profits. Food security in Malaysia is measured based on the adequacy of the population's domestic rice supply. Smart farming offers a transformative approach to modern agriculture, focusing on increasing value while reducing costs. Therefore, this study aims to explore challenges and adoption factors among paddy farmers in Barat Laut Selangor, under the administration of the Integrated Agriculture Development Area (IADA). An exploratory qualitative study involved the interview approach with selected rice farmers who applied smart farming as suggested by IADA. The thematic analysis was used to understand the factors that contribute to the adoption of smart farming among rice farmers and its challenges. This research is critical, given Malaysia is moving towards a high-income country, where sustainability becomes the main agenda in any sector specifically agriculture; and the country has acknowledged the importance of food security assurance. By identifying the challenges and adoption factors, this study aims to provide actionable insights to support sustainable agricultural practices and strengthen Malaysia's food security framework.

Keywords: *Smart farming adoption, rice farmers, smart farming challenges*

1. Introduction

Rice is a critical determinant of national food security; therefore, the country's rice production must align with the growing population. Malaysia's total population in 2022 was 32.4 million, an increase of 1.1 percent (356,400) compared to the year 2017 (Department of Statistics Malaysia, 2023). The increase in demand for rice parallels the increase in population. Therefore, to meet the increased demand for rice, the country needs to import rice. Based on the National Agrofood Policy 2021-2030, by the Department of Agriculture (2021), the level of rice self-sufficiency in 2021 is 73.4 percent, forcing Malaysia to import rice to meet the demand of its population. Therefore, efforts to increase rice production need to be proactive in reducing dependence on imported rice to meet domestic needs, thereby ensuring food security in Malaysia in line with SDG2, which is to achieve zero hunger.

Efforts to deal with the food security issue should not ignore the issue of the uncontrolled use of chemical fertilizers and pesticides in the agricultural sector, because Malaysia is known for the intensive use of fertilizers and chemical pesticides (Adnan et al., 2020). This situation will not only cause pollution to the environment but also affect the health of farmers. In addition, the intensive use of fertilizers and chemical pesticides also causes soil fertility to decline and crop productivity will also decrease from time to time. Therefore, the use of technology that can measure the rate of soil nutrients is important to be applied so that fertilizers or other agricultural inputs can be applied according to the rate required by the plant. With this approach, the use of agricultural inputs can be reduced and indirectly reduce the operating costs that farmers have to bear.

The utilization of smart farming technology in the country's rice production is believed to be an effective effort to achieve one of the priorities outlined in the 12th Malaysia Plan which is to strengthen the application of smart farming in the agro-food sector to meet the Industrial Revolution 4.0 (4IR) wave. This is also in line with

our new National Agrofood Policy 2021-2030 (DAN 2.0) where modernization and smart agriculture are the key game-changers for the transformation of the Malaysia agro-food sector. This is echoed by Mohd Nadzuar et al. (2024), who state that the implementation of smart agriculture has many benefits for the agriculture sector, especially for major plantations. In addition, the use of smart farming technology will provide synergy to the transformation of agriculture towards the next level of productivity and profitability. Through smart farming, all functioning parts in the agri-food production chain will be modified because it involves the processing of related data in a large amount in an instant which will enable more efficient work, good economic returns, greater environmental benefits and better working conditions in the field (Sadiku et al., 2020). In addition, Abang Ahmad et al. (2024) emphasized that smart farming is a new approach to farm management that is gaining attention from various players in the agricultural sector.

The agricultural sector is currently transforming modern technology integration that can improve the quality and productivity of agricultural products and reduce production costs. This can be accomplished by implementing new technologies that can increase the productivity of agricultural operations through the establishment of cost-effective sensor and network platforms meant to cut down on the consumption of energy and water resources and lessen the environmental impact of agricultural activities (Alqarni et al., 2022). Apart from that, smart farming technology, also known as precision farming, can reduce operating costs through water, fertilizer and pesticide input optimization (Gabriel & Haritharan, 2020). Smart farming is an emerging farm management approach to multiply the productivity and quality of agricultural products through the application of modern technology that combines information and communication technology into devices such as IoT, drones, and artificial intelligence (AI). In addition, the use of smart farming is able to reduce production costs and subsequently increase farmers' income (Balafoutis et al., 2020).

The application of smart farming technology in the Malaysian rice cultivation sector started in 2001 in Sawah Sempadan, Tanjung Karang, Selangor. The smart farming technology is known as PADDY-GIS. PADDY-GIS is a decision support system (DSS) tool that helps farmers manage paddy fields (Abdul Aziz et al., 2008). This tool helps farmers in making the right decisions towards reducing input wastage and increasing their profits without marginalizing the quality of the environment. In addition, the Malaysian Agricultural Research and Development Institute (MARDI) as a research institution has developed several smart farming technologies such as land leveling systems and seed sowing with conversion rates (Rahim et al., 2018). The land leveling system is based on the precise land leveling ratio with setting index and seed sowing which contribute to the increase in seed germination in the whole plot uniformly. Besides that, Kamal and Amin (2010) developed a Geographical Information System (GIS) which is a smart farming technology that uses a user-interface technique to control the water balance in paddy cultivation areas. Furthermore, smart farming technology in the form of autonomous robots and drones is also used to monitor crop biomass, pest damage, and weed conditions at high spatial solutions (Mat Lazim et al., 2020). This technology benefits farmers by saving time and increasing rice yields. According to Bujang and Abu Bakar (2019), smart farming technology applications have more potential to be introduced to farmers in granary areas because granary areas are under the management of an agency (e.g., IADA). In addition, the usage of smart farming technology can directly address the problem of land, labor shortage and rising costs faced today in the rice sector in Malaysia (Che Omar, Shaharudin & Tumin, 2019; Najim et al., 2007).

In Malaysia, there are twelve rice granary areas operated by several agencies, namely MADA (Muda Agricultural Development Authority), KADA (Kemubu Agricultural Development Authority), IADA Kemasin Semerak (Integrated Agriculture Development Area Kemasin Semerak), IADA Barat Laut Selangor, IADA Pulau Pinang, IADA KETARA, IADA Pekan, IADA Rompin, IADA Seberang Perak, IADA Kerian, IADA Kota Belud and IADA Lupar. The country's paddy granary area is a strategic intervention by the government to strengthen the nation's food security. Therefore, many rice yield improvement programs including the application of smart farming technology are conducted in granary areas (Abdul Aziz et al., 2008). The use of smart farming technology in farms has benefited farmers in such a way that operating costs are reduced, the quantity and quality of farm products are increased and the environment is protected from potentially harmful farm waste or chemicals used in farm operations (Mat Lazim et al., 2020; Dung & Hiep, 2017). Recognizing these benefits, farmers are encouraged to adopt smart farming technology to ensure agricultural productivity can be increased without jeopardizing biodiversity, the environment, and human health. Therefore, this study is conducted to explore

challenges and adoption factors among paddy farmers. This study was conducted in the country's rice granary area which is in the Integrated Agriculture Development Area (IADA) North West Selangor.

The need to meet the objective of food security is concurrent with the Sustainable Development Goals (SDG) of the United Nations because it focuses on the eradication of poverty and hunger through the approach of sustainable agricultural practices taking into account economic, social and environmental issues. Furthermore, food security plays an important role in improving health outcomes, as inadequate nutrition can lead to malnutrition and increase the prevalence of diet-related chronic diseases.

Hunger and malnutrition are widely regarded as among the most pressing global challenges of the 21st century. In 2019, approximately 690 million individuals were affected worldwide (FAO, 2019). The COVID-19 pandemic further intensified the crisis, with an additional 132 million people facing hunger in 2020 due to the widespread disruptions caused by the pandemic (Klassen & Murphy, 2020). The string from the issue of food insecurity can lead to disruption of the country's social and political order. Recent studies emphasize the need to address food safety using a multidimensional and interdisciplinary approach. There is increasing recognition of the importance of food systems in achieving food security, along with the need to transform them for greater sustainability and resilience (Gabriel & Harithran, 2020).

It is important to address the social and economic factors that lead to food insecurity, such as poverty, inequality and conflict (FAO, 2019). Poverty remains a fundamental barrier to food security as individuals and households with limited income often cannot afford nutritious food, leading to malnutrition and long-term health complications. Inequality, whether in terms of income distribution, access to resources, or opportunities, exacerbates food insecurity by marginalizing vulnerable populations, including women, children, and rural communities. If the issue of food security is not overcome it will lead to a global scale issue which is a threat to human health, economic development and social stability. Therefore, to effectively address this challenge, it is important to use a multidimensional and interdisciplinary approach. This approach must take into account the holistic and complex interactions between food systems, social factors, economics, and environmental sustainability.

The existing body of research on food security highlights its multifaceted nature, calling for a comprehensive, interdisciplinary approach to address this critical issue. Contemporary studies have identified various factors influencing food security, such as food waste, climate change, socioeconomic disparities, agricultural policies, access to nutritious food, and the principles of food sovereignty and security (Wolfson et al., 2020; FAO, 2019). Despite these insights, substantial gaps remain in the literature that hinder progress toward sustainable development. For instance, topics like food sovereignty and food waste have not received adequate attention. Moreover, the interplay between food security and other global challenges, such as gender inequality and environmental sustainability, remains underexplored. Additionally, limited research focuses on the lived experiences and perspectives of marginalized communities (Paslakis et al., 2020), leaving critical dimensions of the issue insufficiently addressed.

To bridge these gaps, recent studies advocate for integrating a variety of perspectives and voices into food security research. They also highlight the need to focus on less-explored topics and their connections to broader global challenges. Moreover, fostering stronger partnerships and collaborations between researchers, policymakers, and practitioners is essential. Enhancing methods for data collection and analysis is also critical to effectively addressing the multifaceted nature of food security challenges (FAO, 2021). The prevailing body of food security literature underscores the pressing need to tackle this significant global challenge through an integrated and interdisciplinary framework. Such a framework should account for the intricate relationships between food systems and a range of social, economic, and environmental dynamics. It should also incorporate insights from recent studies addressing related issues, including food waste, climate change, socioeconomic disparities, agricultural policies, equitable access to nutritious food, and the principles of food sovereignty and security. This article aims to deepen the understanding of food security as a vital global concern while providing valuable guidance for researchers, policymakers, and practitioners. It seeks to address existing gaps in the literature and propose strategies to enhance global food security, fostering a more sustainable future.

2. Methodology

This study uses a qualitative approach. The data required to meet the objectives of the study were obtained and collected through interviews with rice farmers. An in-depth interview of about 1-2 hours with farmers was conducted after receiving a list of potential farmers as respondents suggested by IADA, Barat Laut, Selangor. A total of seven farmers have been involved as respondents for this study. The characteristics of the respondents are rice farmers who have used smart farming technology in rice planting activities for at least 1 season. The interviews were conducted either on the participants' paddy farms or at locations convenient for them. Each session was audio-recorded and subsequently transcribed to facilitate data analysis. Respondent's demographic information was gathered after the interviews. The initial segment of the interview aimed to capture participants' experiences as paddy farmers and their perceptions of smart farming. The latter portion delved into the internal and external factors that influence their readiness to adopt or the challenges they face in implementing smart farming practices. Interviews were conducted according to methodological guidelines up until the point of data saturation (Bryman, 2016). Every interview was analyzed using thematic analysis, involving searching the recurring themes across the data set. The thematic analysis is driven by a few particular analytic questions. In this case, the identified themes, codes, and patterns served as accurate reflections of the content of the entire data set in the interviews (Levitt et al., 2017; Corbin & Strauss, 2008). Themes or patterns within data were identified in a theoretical or deductive or 'top-down' way (Levitt et al., 2017). The analysis in this study is primarily guided by the researchers' theoretical and analytical interests, making it inherently more analysis-driven. Themes were identified at a latent or interpretative level, allowing for an exploration of the deeper significance of observed patterns, their broader implications, and their connection to existing literature. This approach involved examining the underlying ideas, assumptions, and conceptual frameworks that shape and inform the data's semantic content. Thematic analysis was particularly suitable for this study, given the relatively novel nature of the research area and its alignment with the study's objectives.

3. Findings and Discussion

Smart Farming Practice Among Farmers

Seven respondents who were interviewed used smart farming technology, which is drones. Based on interviews conducted, most of the smart farming technology that farmers are exposed to is drones. Many technology-based companies also promote drones to farmers. Therefore, farmers' awareness of using drones is higher than other smart farming technologies. In the interview, the respondents recognized several benefits of using this technology in agriculture based on their experience and intuition. These advantages include spraying pesticides and fertilizing crops, detecting disease in the paddy field, monitoring climate change, and accessing the health of the crop.

Adoption of Smart Farming

Based on interviews and analyses that have been carried out, the themes related to smart farming adoption that have been identified are (1) awareness, (2) engagement, (3) perceived usefulness, and (4) attitudes.

The use of smart farming technology is the latest trend in the agricultural sector, especially in rice cultivation. Therefore many technology-based companies are advertising and promoting smart farming technology and increasing farmers' awareness of this technology. According to Akpojotor (2016), awareness encompasses comprehension or observation of a circumstance, facts, awareness, identification, realization, grasp, and acknowledgment. In addition, information obtained from farmers who have used drones also provides awareness to farmers regarding technology.

I know this drone technology from technology companies that do demonstrations in this area (Respondent 6 and Respondent 7)

Farmer friends also talk a lot about this drone technology (Respondent 3)

The second theme is the engagement factor. Engagement of rice farmers with the application of smart farming technology or drones is from courses and workshops organized by extension agencies and collaborations with technology base companies. Although the knowledge of smart farming technology among extension agency

officers is still new, the extension agency has taken initiatives by collaborating with the technology-based company.

Learned a lot from companies that promote drones during courses organized by IADA (Respondent 2 and Respondent 4)

Perceived usefulness among rice farmers towards the use of smart farming technology or drones is from the point of view of this technology being able to apply fertilizers and pesticides in the right quantity. Fertilizers and pesticides to be sown in rice fields using drones have been accurately measured and the spread of pesticides and fertilizers is also even. In addition, the use of drones for pesticide application can also prevent farmers from being exposed to it. The use of drones can also save time for work in the rice fields, especially the work of applying pesticides and fertilizers.

We can see the advantages of using this drone...Fertilizers and pesticides are spread evenly throughout the rice fields and the measurements are also accurate (Respondent 1).

If fertilizing and pesticide are applied manually, the estimated time required for 1 hectare of rice fields is 2 to 3 hours. With the use of drones, 1 hectare takes only 30 minutes...a lot of time can be saved (Respondent 3).

The last theme is attitude. A positive attitude is one of the important factors in the acceptance of smart farming technology. The farmer's attitude towards the desire to try something new is the driving force for the adoption of smart farming. In addition, encouragement from family, farmer friends and development agencies have also formed a positive attitude towards the use of smart farming.
At first, I was not sure about the use of drones but my farmer friends and family encouraged me and convinced me...even though my friends are still new to using drones the advantages and benefits of using drones have made me want to try. (Respondent 4 and Respondent 5)

Challenges of Smart Farming Adoption
Based on interviews that have been conducted with rice farmers, the challenges stated can be summarized into several categories, namely high costs, complicated and difficult-to-understand handling, and no comprehensive disclosure related to the use of drone technology from the development agency.
The high cost is associated with the high price of owning a drone. Respondents stated the price of a drone unit is in the range of RM 20,000 to RM 25,000. Although the government provides incentives to farmers who want to buy drones, the price is still high.

The price of a drone is very high and farmers can't afford to buy it. If the farmer is a full-time rice farmer, it is quite burdensome to have a drone. Most of the farmers who can afford drones are farmers who have jobs other than rice farming. Therefore, farmers who do not own drones can only rent drones from drone owners to perform certain activities such as applying pesticides and fertilizers. (Respondent 3)

In addition, the challenge to adopt drones expressed by farmers is the complicated handling. Drones are advanced and it is synonymous with youth. Although older rice farmers acknowledge the advantages of using drones such as being able to save time on work in the rice fields, especially the work of sowing seeds, fertilizing and poisoning, the obstacle to the adoption of drones is the difficulty in understanding how to operate them.

Drones are complicated to use. Even if we want to learn, it's hard for us to understand. Unlike young people who like technology. (Respondent 4 and Respondent 5)

The next challenge is the lack of comprehensive exposure to drone applications among farmers. This challenge is linked to low knowledge about drones among extension agencies. Drones are the latest technology that is still new in the agricultural sector. Therefore, time is needed to increase knowledge about this technology among development agencies.

The extension agency has created a course to increase farmers' awareness about drones. But the course is not hands-on. Officers are also new to this technology. (Respondent 1 and Respondent 2).

4. Conclusion

Rice farmers recognize the benefits of drones, including the precise application of inputs and monitoring of crop health. Key adoption factors include awareness, engagement through courses, perceived usefulness, and positive attitudes toward trying new technologies. According to the research findings, several recommendations and policy implications can be proposed to address the challenges of adopting smart farming among rice farmers. First, to effectively reduce the high costs of smart farming technologies such as drones, the financial assistance programs should be expanded, including subsidies and low-interest loans. Apart from that, farmers who have financial constraints to buy smart farming technology can take the initiative by forming a pool of resources through a cooperative so that the costs incurred to buy technology can be shared. This step can foster collective problem-solving and reduce individual financial burdens. This will ensure that smallholder farmers are more accessible and can benefit from these innovative tools. Second, training programs should be implemented in hands-on sessions to address the complexity of operating advanced technologies, particularly targeting older farmers who may require additional support. Third, collaboration between development agencies and technology providers must be heightened to ensure comprehensive exposure and knowledge transfer regarding smart farming applications. Finally, policymakers should create a clear framework to promote smart agriculture and ensure sufficient resources and effective extension services to support its implementation. These measures can significantly improve food security, align with Malaysia's sustainable development agenda and help modernize the agricultural sector.

Acknowledgment: The authors would like to thank Universiti Teknologi MARA (UiTM) for funding this research under the UiTM Grant Myra (600-RMC/GPM LPHD 5/3 (147/2021). Warmest thanks are also delivered to the Integrated Agriculture Development Area (IADA) Barat Laut, Selangor, Malaysia and all the respondents involved in data collection for this research**.**

References

Abdul Aziz, F. A., Mohamed Shariff, A. R., Mohd Soom, M. A., Abdul Rahim, A., Johanshiri, E. & Che' Ya, N. N. (2008). GIS-Based System for Paddy Precision Farming. World Conference on Agricultural Information and IT, 2008.

Adnan, N., Md Nordin, S. & Anwar, A. (2020). Transition pathways for Malaysian paddy farmers to sustainable agricultural practices: An integrated exhibiting tactics to adopt Green fertilizer, Land Use Policy, 90, 104255, https://doi.org/10.1016/j.landusepol.2019.104255.

Alqarni, M., Almalki, F., Soufiene, B., Ali, O., & Albalwy, F. (2022). Authenticated wireless links between a drone and sensors using a blockchain: the case of smart farming. Wireless Communications and Mobile Computing, 1-13. https://doi.org/10.1155/2022/4389729

Akpojotor, O. L. (2016). Awareness And Usage Of Electronic Information Resources Among Postgraduate Students Of Library And Information Science In Southern Nigeria.

Balafoutis, A. T., van Evert, F. K., & Fountas, S. (2020). Smart farming technology trends: Economic and environmental effects, labor impact, and adoption readiness. Agronomy, 10(5), 743. https://doi.org/10.3390/agronomy10050743

Bolfe, É. L., Jorge, L. A. de C., Sanches, I. D., Luchiari Júnior, A., da Costa, C. C., Victoria, D. de C., Inamasu, R. Y., Grego, C. R., Ferreira, V. R., & Ramirez, A. R. (2020). Precision and Digital Agriculture: Adoption of Technologies and Perception of Brazilian Farmers. Agriculture, 10(12), 653. https://doi.org/10.3390/agriculture10120653

Bryman, A. (2016). Social research methods (5th ed.). Oxford University Press

Bujang, A. S. & Bakar, B. A. (2019). Precision agriculture in Malaysia. Proceedings of International Workshop on ICTs for Precision Agriculture, 6–8 August 2019, 91–104. Mardi Headquarters, Selangor, Malaysia.

Che Omar, A., Shaharudin, A., & Tumin, S. A. (2019). The Status of the Paddy and Rice Industry in Malaysia. Khazanah Research Institute.

Corbin, J., & Strauss, A. (2008). Basics of qualitative research: Techniques and procedures for developing grounded theory (3rd ed.). Sage Publications, Inc. https://doi.org/10.4135/9781452230153

Dhanaraju, M., Chenniappan, P., Ramalingam, K., Pazhanivelan, S., & Kaliaperumal, R. (2022). Smart Farming: Internet of Things (IoT)-Based Sustainable Agriculture. Agriculture, 12(10), 1745. https://doi.org/10.3390/agriculture12101745

Dayang Siti Norhafiza Abang Ahmad, Fazleen Abdul Fatah, Abdul Rahman Saili, Jamayah Saili, Nur Masriyah Hamzah, Rumaizah Che Md Nor, & Zubaidah Omar. (2024). Exploration of the Challenges in Adopting Smart Farming Among Smallholder Farmers: A Qualitative Study. Journal of Advanced Research in Applied Sciences and Engineering Technology, 45(1), 17–27. https://doi.org/10.37934/araset.45.1.1727

Dung, L. T., & Hiep, N. T. H. (2017). The revolution of Agriculture 4.0 and sustainable agriculture development in Vietnam. Proceedings of International Conference on Emerging Issues in Economics and Business in the Context of International Integration National Economics University Press Hanoi, December.

Emelogu, N. U., Nwafor, C. K., Chigbu, G. U., Okoyeukwu, N. G., & Eze, K. O. (2022). Awareness, proficiency and challenges in the use of emerging technologies by ESL university lecturers in the post-COVID-19 ERA. Cogent Education, 9(1). https://doi.org/10.1080/2331186x.2022.2084962

FAO (2019). Prospettive agricole ocse-fao 2019-2028.. https://doi.org/10.1787/6b912624-it

Food and Agriculture Organization of the United Nations. (2005). Trade reforms and food security: Conceptualizing the linkages. Food and Agriculture Organization of the United Nations.

Gabriel, W. W. E. & Haritharan, D. (2020). The Development of Smart Farming Technologies and Its Application in Malaysia. International Journal of Scientific & Technology Research, 9(08).

Kamal, R. M., & Amin, M. S. M. (2010). GIS-based irrigation water management for precision farming of rice. International Journal of Agricultural and Biological Engineering, 3(3), 27–35.

Klassen, S. and Murphy, S. (2020). Equity as both a means and an end: lessons for resilient food systems from Covid-19. World Development,136, 105104. https://doi.org/10.1016/j.worlddev.2020.105104

Levitt, H. M., Motulsky, S. L., Wertz, F. J., Morrow, S. L., & Ponterotto, J. G. (2017). Recommendations for designing and reviewing qualitative research in psychology: Promoting methodological integrity. Qualitative Psychology, 4(1), 2–22.

Malaysia, Department of Agriculture. (2020). Crop Statistics (Food Crops Subsector) 2020.

Mat Lazim, R., Mat Nawi, N., Masroon, M. H., Abdullah, N. & Mohammad Iskandar, M. (2020). Adoption of IR4.0 in the Agricultural Sector in Malaysia. Potential and Challenges. Advances in Agricultural and Food Research Journal; 1(2), a0000140.

Mohd Nadzuar, N., Abdul Fatah, F., Saili, A. R., Abang Ahmad, D. S. N., Ali, F., Aziz, N. N. H., Wondi, M. H., & Ekawati, E. (2024). The Benefits of the Adoption of Smart Agriculture in Oil Palm Estates: A Qualitative Study. Journal of Advanced Research in Applied Sciences and Engineering Technology, 290–298. https://doi.org/10.37934/araset.60.1.290298

Najim, M. M. M., Lee, T.S., Haque, M. A. & Esham, M. (2007). Sustainability of Rice Production: A Malaysian Perspective. Journal Of Agricultural Sciences.

Paslakis, G., Dimitropoulos, G., & Katzman, D. K. (2020). A call to action to address COVID–19 induced global food insecurity to prevent hunger, malnutrition, and eating pathology. Nutrition Reviews, 79(1), 114-116. https://doi.org/10.1093/nutrit/nuaa069

Rahim, H., Abdul Wahab, M. A. M., Mat Amin, M. Z., Harun, A. & Haimid, M. T. (2008). Perception and Acceptance of Farmers on Precision Farming Technology in Selected Granary Area. Economic and Technology Management Review, 13, 97–110.

Strauss, A., and Corbin, J. (2008). (3rd Ed.) Thousand Oaks, London, New Delhi: SAGE Publications

Sadiku, M., Ashaolu, T., Ajayi-Majebi, A., & Musa, S. (2020). Smart farming. International Journal of Scientific Advances, 1(3). https://doi.org/10.51542/ijscia.v1i3.2

Wolfson, J. A. and Leung, C. W. (2020). Food insecurity and COVID-19: disparities in early effects for us adults. Nutrients, 12(6), 1648. https://doi.org/10.3390/nu12061648