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Adoption of Smart Farming Technology Among Rice Farmers

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ABSTRACT

Application of smart farming technology in rice farming activity is relevant in facing the challenges in achieving food security and improving the wellbeing of farmers. In Malaysia, food security is synonymous with the adequacy of rice domestic supply for the Malaysian population. Therefore, to achieve the target set in Sustainable Development Goal 2 which is to achieve zero hunger, the rice sector needs to be more competitive by encouraging farmers to utilize modern technology. Smart farming is an emerging concept of farm management that combines information and communication technologies into modern machinery like IoT, drones, and Artificial Intelligence to increase the value of agricultural products as well as reduce the cost of production while improving the well-being of farmers through income increment. Therefore, this study is conducted to explore the adoption of smart farming among paddy farmers in one of the country's granary areas which is in Barat Laut Selangor under the administration of the Integrated Agriculture Development Area. This study will employ qualitative methods and interviews will be conducted. This study is urgently needed due to the twofold agenda: Malaysia is moving towards a high-income country and the importance for food security assurance has been acknowledged.

1. Introduction

Rice is a major meal for more than half of the worldwide people, which cultivates mostly in Asia and produces over 90% of the nation's rice. Rice and paddy are therefore key components of food availability, socio-cultural evolution, and government strategic measures in a large number of developing nations [1,2]. In Malaysia, due to a lack of economies of scale, it is hard when it comes to achieving 100 percent self-sufficiency. Up to now, Malaysia's rice output self-sufficiency level is at 73%. However, the demand for rice always increases every year proportionate with the increment in Malaysia's population [3]. In addition, rice cultivation is highly reliant on weather systems, causing changes in weather systems to give negative impact on the country's rice productivity [4]. Therefore, to cope with all the challenges and the rising demand, Malaysia has been importing about 30 to 40

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percent of its rice consumption annually for the last 20 years. Pursuant to the Department of Statistics Malaysia [5], Malaysia's imports of rice in 2020 were valued at RM2.5 billion, representing a 32.1% increase from the preceding year. Nevertheless, the time has come for Malaysia to reduce its dependence on imported rice to meet domestic demand by learning from the Covid-19 crisis. In addition, several series of food crises emerge such as food price hikes; shortages of essential food such as oil and chicken and rush purchase augmented the reasons to address food security issues more seriously.

One of the potential efforts is the application of agricultural technology. Agriculture has become more reliant on technology in recent years. The advancement of technology has changed the dynamics of how human perform their activity in all sectors for the purpose to increase productivity, especially in agricultural sector [6]. In the rice sector context, potential rice production towards 10mt/ha can be achieved by using technological advances such as precision farming by using smart farming technology or Internet of Things (IoT). IoT is an embedded device with sensors, software and other technologies for the purpose of connecting and exchanging data with other devices and it functions through the internet [7,8]. Additionally, the adoption of smart farming may directly solve the issues of land scarcity, manpower lack, and growing cost of production now confronting Malaysia's rice industry [9,10]. Mohamed *et al.,* [8] agree that the application of IoT can increase productivity. The prospect of implementing advance technology practices is observed more viable in granary areas, where it is under management of large corporation, for instance rice farming started with the introduction of smart farming in 2001 at IADA Barat Laut Selangor, known as PADDY-GIS [13]. PADDY-GIS is a decision support system (DSS) application that assists farmers in managing their paddy fields PADDY-GIS is a type of precision farming by using smart farming technology. It works by adapting information and communication technology (ICT) through various technology including the GIS technology [11].

Precision agriculture is an approach in managing a farm in a way to fulfil the needs of individual fields and crops by observing, measuring and analysing by using technology [12]. Precision farming using smart farming technology is an effective management practice in agriculture for the purpose to sustenance of crop production. With the emergence of Industrial Revolution 4.0 (IR 4.0), the precision farming has become a key indicator towards the modernization of agriculture in an effort to help farmers increase agricultural productivity and further guarantee farmers well-being. Precision farming practices using smart farming technology allow farmers to collect and generate high-quality agricultural data such as crop and soil element data so that it can facilitate them on the necessary decision for managing their crop. Several recent and advance technology in smart farming are Remote Sensing, Geographic Information Systems (GIS) and Global Positioning Systems (GPS) [11,13]. Therefore, smart agriculture needs to be comprehensively integrated in the country's rice cultivation activities because the issue of rice consumption that is constantly increasing due to the increase in population is always the main agenda in food security discussions. Therefore, this study is conducted to explore the adoption of smart farming technology among paddy farmers in one of the country's granary areas which is in Barat Laut Selangor under the administration of the Integrated Agriculture Development Area (IADA).

Farmers' attitudes regarding new technology may be crucial component in explaining farmers' adoption of new agricultural techniques. Attitude is a fundamental, inherent concept in social psychology that has been extensively employed in the study of human behaviour [5,14]. Attitudes, as a notion, help to assess whether an item or activity is good or unpleasant. In summary, it has been characterised as an indicator of how strongly someone loves or hates an idea, concept, or viewpoint toward others [15]. In agriculture, an individual farmer's decision-making process allows for the examination and formulation of positive or negative views about agricultural practises, including new

technology. Although it may not always be feasible to assess the process of belief development, attitudes may be seen via the choices people make, according to core ideas on attitudes [16]. Smallholder farmers in agricultural production have been shown to evaluate the value of agricultural innovations in the same way that they do other technologies [14]. Confidence in applying smart farming technology, views of net advantages, and farm size all positively affected the desire to embrace agricultural precision technologies [17].

Farmers who have witnessed and experienced the use of smart farming on the plots of other farmers have a vastly greater desire to participate in several features of smart agriculture technologies, indicating that having the opportunity to observe and experience the use of smart farming on the plots of a peers farmer enhances the probability of adopting these technologies. Social relationships appear to be critical for the adoption of smart agriculture technologies, confirming that earlier research on the embracing and dissemination of agricultural technology also applies to smart agriculture technologies. Blasch *et al.,* [18] uncovered that social ties are especially strong among farmers who have implemented innovations on their farms in the preceding years, so it can be assumed that smart farming will first spread within clusters of innovative farmers before spreading to the larger farmer population. Therefore, this study is conducted to explore the adoption of smart farming among paddy farmers in one of the country's granary areas which is in Barat Laut Selangor under the administration of the IADA.

2. Methodology

This research will be conducted with rice farmers under IADA in Barat Laut, Selangor. The IADA Barat Laut, Selangor located at 3.3350° N, 101.2518° E. In this qualitative study, the researcher typically examines meanings and insights in a specific scenario [19,20]. It is a set of methods for obtaining and analyzing data that include purposive sampling and semi-structured, open-ended interviews [21,22]. It is viewed as an efficient model that emerges in a realistic context and aids the researcher to establish a degree of depth via active participation in actual events [23]. Snowball sampling was chosen due to accessing participants with the desired characteristics is challenging [24]. In this study, current research participants recruit prospective study participants from their professional network, and sampling continues until the data is saturated. To achieve data saturation in qualitative research, it has previously been advised that a minimum sample size of 12 be used [25-27]. The selection of the participants is based on a few predetermined criteria which were the respondent must be familiar with the smart farming technique in cultivating paddy, the respondent might cultivate the paddy using the smart farming technique or had business with the person that cultivate the paddy using smart farming technique and the respondent must be the primary actor in the paddy field. Besides, the thematic analysis technique is used to find, analyse, and report patterns (themes) [28]. The insights and thoughts gathered from participants finally were transcribed. According to Halcomb and Davidson [29], transcribing is the act of reproducing audible words into text, such as those from an audio-recorded interview. Other complicated definitions exist, however, because it is not restricted to the essential actions of hearing and writing. The process of turning oral speech into written words is fraught with difficulties, but they may be overcome with careful planning [30].

3. Results and Discussions

Based on the results, it can be generalised that there were three themes used in this study. The first theme discussed on current technology used by rice farmers. Recently, most farmers used

drones. Based on the interview, the participants acknowledged that there were many benefits of using it in agriculture according to their experience such as spraying pesticides and fertilizing crops, detecting disease in the paddy field, monitoring climate change, and accessing the health of the crop. The second theme was rice farmers' perceptions of and attitudes toward smart farming technology. These findings were reinforced by the Theory of Planned Behavior, which stated that attitudes, as a concept, aid in determining whether an object or activity is pleasant or not. In brief, it has been defined as a measure of how intensely someone loves or dislikes an idea, concept, or point of view toward others [15]. As for this theme, the adoption intention involved were (1) awareness, (2) engagement, (3) perceived usefulness, and (4) attitudes. Awareness refers to farmers' willingness to study technological solutions to agricultural concerns. Thus, smart farming applications will affect the awareness and acceptance of individuals. In terms of engagement, farmers usually utilized traditional agricultural equipment, such as tractors and seeding machinery rented from machine cooperatives. The most often mentioned barriers to testing and adoption were the expensive cost of technology and the low profitability of farming. Farmers were confused about where to get technology and formal information-providing methods other than those pushed by government-sponsored yearly training programs and demonstration projects, and they saw a shortage of local agricultural extension agents. Drones for pesticide applications, on the other hand, were well received, particularly among farmers in IADA Barat Laut, Selangor, a government-sponsored demonstration area where drones were sold for time and labour savings. The promotion has aided in increasing farmer participation. As for the perceived usefulness, it refers to the expected benefits revolving around smart farming's ability to provide economic benefits by reducing inputs (e.g., time, labor, seeds, and agrochemicals) while boosting output. Lastly, a farmer's attitude is defined as a mental propensity that determines how he thinks or feels about something. In the context of technology, an attitude refers to one's positive or negative assessment of the introduction of new forms of technology in any scenario. Table 1 below showed the summary of the adoption intention of smart farming technology. The final theme discussed the challenges faced by rice farmers to adopt smart farming. The participants perceived several risks in order adopting this new technology which were higher capital expenditure to buy and maintain, the acceptance of old farmers toward smart farming, lack of knowledge, experienced, information and training about smart farming and lack of financial support from the government as well.

Regarding to the research finding, smallholders in IADA Barat Laut, Selangor mostly used drone in order to manage their paddy field. Generally, on a global basis, this technique has been employed in numerous applications such as land suitability, flood monitoring, the environment, and agriculture [31]. Previous research was done by Sari *et al.,* [32] at Sawah Sagil, Johor, using UAV and RGB images proved successful in monitoring the rice plot condition at an early stage. Drones have traditionally been used for data (picture) collection in more sophisticated agricultural economies. This differentiation is also made more generally possible by the legislative framework, which permits the use of UAVs for agrichemical applications.

Table 1
Summary of the adoption intention of smart farming

Awareness	• Being near a demonstration field provided farmers with first-hand knowledge of smart agriculture applications. • Regional marketing, for example, has raised public knowledge and acceptance of several smart farming applications. • Instead of using more official channels such as research institutes, corporations, or agronomy service providers, the information was collected through informal peer-to-peer networks made possible by the extensive applications of cell phones and television.
Engagement	• A government-sponsored trial field for farmers where UAVs were marketed for time and labor savings. • In the lack of professional service providers at the time, collaboration and informal rental markets grew through colleagues for farmers who were unable spend money directly in technology. • Farmers decide to use drones to sow fertilizer as well as seeds. In the past year, they also used mapping to determine the level of damage, the level of fertilizer, and the condition of the crops. • Farmers used a drone to spray pesticides and fertilize the crops by themselves because there are not many workers
Perceived usefulness	• Can apply fertilizer and pesticide in the correct amount. • Can do the management of the crop at the exact time and follow the schedule. • Helps to improve work efficiency and safe time. • Machine advancements have accelerated the pace, velocity, and efficiency of farm implements, resulting in the more effective cultivation of more area. • Recognized for improving the efficiency with which weed control or fertilizers are dispersed, enhancing field management, and providing precise field mapping.
Attitudes	• Want to try something new in order to increase the productivity and quality of crops and think smart farming is a faster way compared to conventional practices. • Great external supports from family, friends, and governments motivate and encourage farmers a lot to involve in the application of smart farming. • The farmers are willing to accept any new technology and have a positive impression of its results. • Farmers acknowledged that smart farming is far better compared to traditional farming.

The outcomes uncovered two types of farmers: (1) individuals who are innovators and passionately participate with and invest in smart agriculture technologies, and (2) individuals who were willing to take part but needed affirmation from watching others apply, and were unable to directly focus on innovation but were interested in service provision options. This implies that market stratification to separate adoption characteristics might be beneficial in identifying those most prone to promote adoption within localities, as well as enabling improved performance research and focus of regional extension officers in information dissemination [33]. Because participants frequently reported greater levels of perceived technological preparedness than their behavior reflected, caution must be exercised in order to establish a more objective estimate of this.

Farmer knowledge was usually obtained via social circles such as cellphone platforms (WhatsApp) and witnessing of the advantages gained by other farmers as evidenced by the mass acceptance of UAVs, as well as fears about "falling behind." This emphasises the relevance of mentoring help systems and demonstrates the need of encouraging farmers to join these networks [34,35].

Informal means for teaching and assistance should be combined with more formal educational possibilities, with education level influencing the amount of participation in smart agriculture, with those with formal agricultural education demonstrating stronger attempts to engage. According to

research, encouraging competent agricultural graduates to return to rural regions can aid in the spread of smart farming technology inside rural communities. As a result, it is critical for key stakeholders to recognise the usefulness of both formal and informal education systems in improving interaction with end-users and, as a result, improving existing innovation trajectories [34,36,37].

To soothe farmer worries and remove perceived obstacles connected to economic risks, it is critical to give farmers cost/benefit analysis data, particularly during the decision-making stage. Future study is needed to establish the economic benefits of smart agriculture adoption, especially economic studies that show how smart farming technology may boost farm profitability [38,39]. Finally, a lack of knowledge on financial support mechanisms such as incentives and low-interest financing contributed to the perceived risk of adoption. Improved knowledge and access to a broader range of financial assistance mechanisms, such as financing, leasing, and inexpensive full-service provision and contractor choices, would lower the economic obstacles to adoption [40].

4. Conclusions

The use of semi-structured interviews allowed for more in-depth insight into the personal experiences of smallholder rice farmers working in the Malaysian paddy sector allowing it to be addressed openly and candidly, making the assessment and analysis of the results more coherent a review of the literature was presented corresponding to the research topic on the adoption of smart agriculture among smallholder in paddy sector in Integrated Agriculture Development Area (IADA) Barat Laut, Selangor. Serious research should take into account the opinions of farmers in various Malaysian areas who may be subjected to diverse contextual influences. To help counteract the primary barrier to adoption (cost), economic cost-benefit analysis and information about specific technologies are required, such as demonstrating the long-term economic benefits of adoption and striving to improve interpretations and interaction to assist farmer judgement and uptake. As advocated by institutions, innovation, legislation, and education promoting the adoption of smart farming technologies in emerging agricultural economies should clearly engage farmers and end-users as major stakeholders throughout the process, from original idea conceptualization through product commercialization. Agricultural research and development institutes should focus on enhancing market access for proven and profitable smart agriculture technologies. Providing systematic training courses on the uses of IoT and big data in agriculture may help farmers to engage in smart farming techniques more successfully.

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References

[1] Omar, Sarena Che, Ashraf Shaharudin, and Siti Aiysyah Tumin. "The status of the paddy and rice industry in Malaysia." *Khazanah Research Institute. Kuala Lumpur* (2019).

[2] Fahad, Shah, Muhammad Adnan, Muhammad Noor, Muhammad Arif, Mukhtar Alam, Imtiaz Ali Khan, Hidayat Ullah et al. "Major constraints for global rice production." In *Advances in Rice Research for Abiotic Stress Tolerance*, pp. 1-22. Woodhead Publishing, 2019. https://doi.org/10.1016/B978-0-12-814332-2.00001-0

[3] Barik, Jijnasa, Debabrata Panda, Sangram K. Mohanty, and Sangram K. Lenka. "Leaf photosynthesis and antioxidant response in selected traditional rice landraces of Jeypore tract of Odisha, India to submergence." *Physiology and Molecular Biology of Plants* 25, no. 4 (2019): 847-863. https://doi.org/10.1007/s12298-019-00671-7

[4] Afroz, R., M. Muhibbullah, and M. Z. Rahman. "Poverty of Malaysian rice farmers in a changing climate-An empirical investigation in Kedah, Malaysia." In *IOP Conference Series: Earth and Environmental Science*, vol. 756, no. 1, p. 012012. IOP Publishing, 2021. https://doi.org/10.1088/1755-1315/756/1/012012
[5] DOSM. "Department of Statistics Malaysia 2021. Volume I." Department of Statistics Malaysia. 2021. https://www.dosm.gov.my/v1/.
[6] Adnan, Nadia, Shahrina Md Nordin, Mohamad Ariff Bahruddin, and Ahmad Hussen Tareq. "A state-of-the-art review on facilitating sustainable agriculture through green fertilizer technology adoption: Assessing farmers behavior." *Trends in Food Science & Technology* 86 (2019): 439-452. https://doi.org/10.1016/j.tifs.2019.02.040
[7] Zainal, Salbiah, Rasimah Che Mohd Yusoff, Hafiza Abas, Suraya Yaacub, and Norziha Megat Zainuddin. "Review of Design Thinking Approach in Learning IoT Programming." *International Journal of Advanced Research in Future Ready Learning and Education* 24, no. 1 (2021): 28-38.
[8] Mohamed, Latifah Naina, Yudi Fernando, and Anisha Banu Dawood Gani. "A Conceptualization of Industrial Internet of Things towards Manufacturing Safety Performance." *Journal of Advanced Research in Business and Management Studies* 29, no. 1 (2022): 1-8.
[9] Najim, M. M. M., T. S. Lee, M. A. Haque, and M. Esham. "Sustainability of rice production: A Malaysian perspective." *The Journal of Agricultural Sciences3*, no. 1 (2007): 1-12. http://doi.org/10.4038/jas.v3i1.8138
[10] Bujang, Ahmad S., and Badril H. Abu Bakar. "Precision agriculture in Malaysia." In *Proceedings of International Workshop on ICTs for Precision Agriculture*, 6-8 August 2019, pp. 91-104. 2019.
[11] Aziz, Fauzul Azhan Abdul, Abdul Rashid Mohamed Shariff, Mohd Amin Mohd Soom, Anuar Abdul Rahim, Ebrahim Jahanshiri, and Nik Norasma Che' Ya. "GIS based system for paddy precision farming." In *World Conference on Agricultural Information and IT, IAALD AFITA WCCA 2008, Tokyo University of Agriculture*, Tokyo, Japan, 24-27 August, 2008, pp. 417-422. Tokyo University of Agriculture, 2008.
[12] Wicaksono, Muhammad Galang Satrio, Erma Suryani, and Rully Agus Hendrawan. "Increasing productivity of rice plants based on IoT (Internet Of Things) to realize Smart Agriculture using System Thinking approach." *Procedia Computer Science* 197 (2022): 607-616. https://doi.org/10.1016/j.procs.2021.12.179
[13] Alwaisi, Shaimaa Safaa Ahmed, Maan Nawaf Abbood, Luma Fayeq Jalil, Shahreen Kasim, Mohd Farhan Mohd Fudzee, Ronal Hadi, and Mohd Arfian Ismail. "A Review on Big Data Stream Processing Applications: Contributions, Benefits, and Limitations." *JOIV: International Journal on Informatics Visualization* 5, no. 4 (2021): 456-460. https://doi.org/10.30630/joiv.5.4.737
[14] Edison, Steve W., and Gary L. Geissler. "Measuring attitudes towards general technology: Antecedents, hypotheses and scale development." *Journal of Targeting, Measurement and Analysis for Marketing* 12, no. 2 (2003): 137-156. https://doi.org/10.1057/palgrave.jt.5740104
[15] Ajzen, Icek, and Martin Fishbein. "Attitudes and the attitude-behavior relation: Reasoned and automatic processes." *European Review of Social Psychology* 11, no. 1 (2000): 1-33. https://doi.org/10.1080/14792779943000116
[16] Fishbein, Martin, and Icek Ajzen. *Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research*. Addison-Wesley Publishing, 1975.
[17] Adrian, Anne Mims, Shannon H. Norwood, and Paul L. Mask. "Producers' perceptions and attitudes toward precision agriculture technologies." *Computers and Electronics in Agriculture* 48, no. 3 (2005): 256-271. https://doi.org/10.1016/j.compag.2005.04.004
[18] Blasch, Julia, Bianca van der Kroon, Pieter van Beukering, Renée Munster, Stefano Fabiani, Pasquale Nino, and Silvia Vanino. "Farmer preferences for adopting precision farming technologies: a case study from Italy." *European Review of Agricultural Economics* 49, no. 1 (2022): 33-81. https://doi.org/10.1093/erae/jbaa031
[19] Corbin, Juliet, and Anselm Strauss. *Basics of qualitative research: Techniques and procedures for developing grounded theory. 3rd ed*. Sage Publications, 2008. https://doi.org/10.4135/9781452230153
[20] Levitt, Heidi M., Sue L. Motulsky, Fredrick J. Wertz, Susan L. Morrow, and Joseph G. Ponterotto. "Recommendations for designing and reviewing qualitative research in psychology: Promoting methodological integrity." *Qualitative Psychology* 4, no. 1 (2017): 2-22. https://doi.org/10.1037/qup0000082
[21] Dudwick, Nora, Kathleen Kuehnast, Veronica Nyhan Jones, and Michael Woolcock. "Analyzing social capital in context: A guide to using qualitative methods and data." *The International Bank for Reconstruction and Development/The World Bank: World Bank Institute, Washington, DC-2006* (2006).
[22] Gopaldas, Ahir. "A front-to-back guide to writing a qualitative research article." *Qualitative Market Research: An International Journal* 19, no. 1 (2016): 115-121. https://doi.org/10.1108/QMR-08-2015-0074
[23] Creswell, John W. *Research designs: Qualitative, quantitative, and mixed methods approaches*. Sage Publications, 2009.

[24] Naderifar, Mahin, Hamideh Goli, and Fereshteh Ghaljaie. "Snowball sampling: A purposeful method of sampling in qualitative research." *Strides in Development of Medical Education* 14, no. 3 (2017). https://doi.org/10.5812/sdme.67670
[25] Clarke, Victoria, and Virginia Braun. *Successful qualitative research: A practical guide for beginners*. Sage Publications, 2013.
[26] Fugard, Andrew J. B., and Henry W. W. Potts. "Supporting thinking on sample sizes for thematic analyses: a quantitative tool." *International Journal of Social Research Methodology* 18, no. 6 (2015): 669-684. https://doi.org/10.1080/13645579.2015.1005453
[27] Guest, Greg, Arwen Bunce, and Laura Johnson. "How many interviews are enough? An experiment with data saturation and variability." *Field Methods* 18, no. 1 (2006): 59-82. https://doi.org/10.1177/1525822X05279903
[28] Braun, Virginia, and Victoria Clarke. "Thematic analysis." *Encyclopedia of Critical Psychology* (2014): 1947-1952. https://doi.org/10.1007/978-1-4614-5583-7_311
[29] Halcomb, Elizabeth J., and Patricia M. Davidson. "Is verbatim transcription of interview data always necessary?." *Applied Nursing Research* 19, no. 1 (2006): 38-42. https://doi.org/10.1016/j.apnr.2005.06.001
[30] Lapadat, Judith C. "Problematizing transcription: Purpose, paradigm and quality." *International Journal of Social Research Methodology* 3, no. 3 (2000): 203-219. https://doi.org/10.1080/13645570050083698
[31] Mostafiz, Rubaiya Binte, Ryozo Noguchi, and Tofael Ahamed. "Agricultural Land Suitability Assessment Using Satellite Remote Sensing-Derived Soil-Vegetation Indices." *Land* 10, no. 2 (2021): 1-26. https://doi.org/10.3390/land10020223
[32] Sari, Mohd Yazid Abu, Yana Mazwin Mohmad Hassim, Rahmat Hidayat, and Asmala Ahmad. "Monitoring Rice Crop and Paddy Field Condition Using UAV RGB Imagery." *JOIV: International Journal on Informatics Visualization* 5, no. 4 (2021): 469-474. https://doi.org/10.30630/joiv.5.4.742
[33] Li, Wenjing, Beth Clark, James A. Taylor, Helen Kendall, Glyn Jones, Zhenhong Li, Shan Jin et al. "A hybrid modelling approach to understanding adoption of precision agriculture technologies in Chinese cropping systems." *Computers and Electronics in Agriculture* 172 (2020): 105305. https://doi.org/10.1016/j.compag.2020.105305
[34] Heiniger, R. W., J. L. Havlin, D. A. Crouse, C. Kvien, and T. Knowles. "Seeing is believing: The role of field days and tours in precision agriculture education." *Precision Agriculture* 3, no. 4 (2002): 309-318. https://doi.org/10.1023/A:1021532603441
[35] Kernecker, Maria, Andrea Knierim, Angelika Wurbs, Teresa Kraus, and Friederike Borges. "Experience versus expectation: Farmers' perceptions of smart farming technologies for cropping systems across Europe." *Precision Agriculture* 21, no. 1 (2020): 34-50. https://doi.org/10.1007/s11119-019-09651-z
[36] Clark, Beth, G. Jones, Helen Kendall, James Taylor, Yiying Cao, Wenjing Li, Chunjiang Zhao et al. "A proposed framework for accelerating technology trajectories in agriculture: a case study in China." *Frontiers of Agricultural Science and Engineering* 5, no. 4 (2018): 485-498. https://doi.org/10.15302/J-FASE-2018244
[37] Qian, Wenrong, Dazhe Wang, and Liyi Zheng. "The impact of migration on agricultural restructuring: Evidence from Jiangxi Province in China." *Journal of Rural Studies* 47 (2016): 542-551. https://doi.org/10.1016/j.jrurstud.2016.07.024
[38] Daberkow, Stan G., and William D. McBride. "Farm and operator characteristics affecting the awareness and adoption of precision agriculture technologies in the US." *Precision Agriculture* 4, no. 2 (2003): 163-177. https://doi.org/10.1023/A:1024557205871
[39] Schimmelpfennig, David, and Robert Ebel. "Sequential adoption and cost savings from precision agriculture." *Journal of Agricultural and Resource Economics* 41, no. 1 (2016): 97-115.
[40] Wossen, Tesfamicheal, Thomas Berger, and Salvatore Di Falco. "Social capital, risk preference and adoption of improved farm land management practices in Ethiopia." *Agricultural Economics* 46, no. 1 (2015): 81-97. https://doi.org/10.1111/agec.12142