

INFORMATION TECHNOLOGY (IT) IN AGRICULTURE SECTOR: ISSUES AND CHALLENGES

Nurul Hanis Azrin Sabirin^{*1}, Noor Fadzlina Mohd Fadhil², Juliana Arifin³

*Faculty of Business and Management, Universiti Sultan Zainal Abidin (UniSZA), 21300
Kuala Nerus, Terengganu, Malaysia*

** Corresponding author's e-mail:sl3805@putra.unisza.edu.my*

Received: 29 May 2022

Accepted: 18 August 2022

Online first: 31 August 2022

ABSTRACT

Agriculture is the backbone of food production in every nation and the central element in economic development. Rapid changes in information technology (IT) have promised substantial potential benefits in return, especially for developing countries. The success of IT applications in agriculture is widely reported in numerous previous studies. Regardless of its success, the transformation has brought many issues and challenges for farming businesses. Thus, this article aimed to review the major issues and challenges of IT usage and how technology resources can address the needs of demand for food production. The findings reveal three main themes of issues and challenges, which are infrastructure, people, and organisation. Due to these issues, there is a greater need for changes in IT resources in agriculture to meet food demand for the rapid growth of the population by the year 2050. A systematic review using existing literature has been used in writing this article.

Keywords: *agriculture, human resources, information technology, infrastructure and organisation*



INTRODUCTION

Agriculture is the essential food production source and plays a strategic role in economic development with its own essential and crucial role, especially in most developing countries (Praburaj, 2018). The agriculture industry contributes strategically to increasing food availability and ensuring food security. There is uncertainty over global agriculture's ability to meet this need by increasing the food supply, despite the fact that there is a universal consensus that the demand for food will expand globally in the next decades (Pawlak & Kołodziejczak, 2020). In developing countries, farming businesses are involved with the food security issue, the health of people and food quality improvement (Milovanović, 2014). Implementation of innovative technology such as the Internet of Things (IoT) and big data for smart agriculture can increase the level of quality, quantity, cost-effectiveness and sustainability of production in the farming business (Roukh *et al.*, 2020). New capabilities created by smart farming and advanced technologies could optimise most agricultural processes and allow production processes to achieve higher productivity while using fewer natural resources (Zanella *et al.*, 2020). This can be seen through developed and developing countries where developed countries mainly deal with their food waste in farming industry while developing countries are working hard to secure their supply chain of food production despite the world-wide COVID-19 crises (Ellison & Kalaitzandonakes, 2020).

Generally, Information Technology (IT) is defined as a tool such as computer software and hardware solutions that needed to support the management, operations and strategists to increase the productivity of an organisation (Thong & Yap, 1995). According to another scholar, IT can also be defined as the capabilities offered to an organisation by computers, software, applications and telecommunications to deliver data, information and knowledge to individuals and processes (Attaran, 2003). Technology is developed with objectives of solving industry problems and to fulfill the needs in market (Dardak & Adham, 2014). These days, organisations must adapt to the quick changes in the business environment and look for new ways to compete and set themselves apart from the competition (Victoria, 2020). Technology and innovation are closely related terms associated with science, technique or knowledge, which directed towards using knowledge and science to do something better. The development of new technology

can be simplified as a step-by-step process monitored by a management decision, and each process of developing new technology is referred to as stage-gate product innovation processes (Cooper, 2008).

In agriculture, IT represents modern agriculture where agriculture has been shaped into commercialised and marketed enterprise-type that seek for improvements in digital tools, data and believe to have much more central roles (Yue, 2009; Dutonde, 2018; Sharma & Mungarwal, 2019). IT in agriculture is defined as a tool for direct contribution to agricultural productivity and as an indirect tool for entitling farmers to take information and make quality decisions that would positively impact agriculture activities (Mitra, 2014). Modernised farming can be classified by the technological level and strong integration with domestic and international markets as well as solid policymakers oriented while traditional farming is characterised by limited access to the domestic markets and a shallow level of technology (Ismail *et al.*, 2009). The adoption of technology in agriculture has a huge potential to resolve some issues in agriculture such as limited use of land for agricultural activities, low productivity, disease and pest infestation and lack of labour (Dardak & Adham, 2014). Some types of IT that are being used in the agriculture sector include the IoT (Ayaz *et al.*, 2019), drones, soil moisture sensors plant and soil health (Duangsuwan & Maw, 2020), remote monitoring and security (Triantafyllou *et al.*, 2019).

Nowadays, agriculture is moving towards the Internet and technology. Everyone is considering using artificial intelligence (AI) and the Internet of Things (IoT) as they have significant advantages in the farming industry, especially since the agriculture revolution was sparked by smart farming practices (Ayaz *et al.*, 2019). Previous studies show that farmers involved in the agriculture sector faced several issues either in developed or developing countries due to their agro-ecosystem capabilities, governance and management system. Until 2017, more than 50% of the world's vegetated land for agriculture has been used, and there is a need to prevent using more land as land resources are limited and currently difficult for anyone to access (Ritchie, 2017). According to World Resources Institute, the total human population on this earth is expected to increase nearly to 10 billion people by 2050, thus lead to 56% more food to be produced in future to meet human needs (Ranganathan *et al.*, 2018). However, the effort to produce more foods to meet the population's demand has become crucial (Fróna *et*

al., 2019). It took so many decades for farmers to work hard and experience many changes from traditional to a digital world to supply food to fulfil the food demand. The challenges to produce more food production by 2050 can be overcome by taking some steps in pushing innovation technology adoption among farming business (Tompkins, 2020).

Therefore, the purpose of this SLR study was to inform the farmers about the major issues and challenges concerning usage of IT in agriculture sector. In turn, the insights obtained from this study could affect the farmer's knowledge and awareness regarding IT in the agriculture businesses. Specifically, the SLR performed could assist farmers to identify major challenges and issues regarding IT resources usage in agricultural business thus, could enhance farmer's skills and knowledge in managing IT resources for better productivity.

METHODOLOGY

A literature review is performed to examine the issues and challenges in the usage of IT in the agriculture sector. The purpose of the literature review is to demonstrate an author's knowledge about the specific field of study, including the theories, key variables, phenomena, methods, history and even the vocabulary of a study area (Randolph, 2009). Developing a literature review offers some benefit such as evaluating the strength of the scientific evidence, identifying gaps in the latest research, point out the need for future research, recognise central issues of the study area, generating a research question as well as developing a conceptual framework and also exploring research methods that have been used successfully (Russell, 2005). Similarly, a group of authors defined that literature review plays essential roles in writing to determine the research problem, look for new lines of inquiry, avoiding pointless approaches, gaining methodological understanding, identifying recommendations for further research and seeking support for grounded theory (Gall *et al.*, 1996). In this article, a literature review was conducted based on Cooper (1982) whereby the procedure for synthesising literature consists of (1) problem formulation, (2) data collection, (3) evaluate the appropriateness of data, (4) analyse and interpret the relevant data and (5) organise and present the results. In Table 1, a summary of each stage in literature reviews of Cooper's are listed to assist

the literature chores. In 1988, Cooper developed a taxonomy of literature reviews that could help in the assessment of the quality of reviews. The taxonomy can be classified into five characteristics: focus, goal, perspective, coverage, organisation. These characteristics would allow for broader and systematic literature works considered the crucial steps before planning for literature reviews (Cooper, 1988). Thus, the following parts elaborate on the implementation of Cooper’s stages in conducting literature reviews of this paper.

Table 1: Literature Reviews Guidelines from 'Scientific Guidelines for Conducting Integrative Research Reviews' by Cooper (1982)

Literature Review Guidelines (Coopers, 1982)	
Stage 1	Problem Formulation: Development of conceptual and operational definitions of variables to be examined
Stage 2	Data Collection: Identify the target and accessible population, including determining the inclusion and exclusion criteria of articles
Stage 3	Data Evaluation: Extract and evaluate the information in articles that met the inclusion criteria
Stage 4	Data Analysis: Analysis and interpretation of selected articles
Stage 5	Public Presentation: Gathered and determine selected information to be presented

According to Coopers (1982), the problem formulation stage should include developing conceptual and operational definitions of variables to be examined. Primary researchers must define the conceptual and operational definition by examining how researchers would abstractly conceive the issues under the study area and how the researchers measure the concept (Russell, 2005). A study by Randolph (2009) identified the problem formulation stage as how the researchers decide what questions the literature review answer and determine the goal and focus of the review (Randolph, 2009). In this paper, the researchers outline the major issues and problems that need to be response as the research outcomes. This paper aimed to discuss issues and challenges of IT usage in agriculture businesses. A report published by Food and Agriculture Organization of the United Nations (FAO) back in 2017 highlighted trends and challenges of global agriculture. It was predicted by 2050 that there would be nearly 10 billion people on Earth, and currently, there is a significant shortfall between the amount of food produced today and the amount needed to feed the whole population in 2050 (FAO, 2017). In this report, FAO also show up several issues of

global agriculture that led to limited agricultural production, which are (1) increasing scarcity, (2) diminishing quality of land and water resources, (3) climate changes and (4) insufficient investment in sustainable agriculture that related to technologies innovation. This problem mainly affected developing countries as developed countries deal with their overproduction in farming crises while developing countries are working hard to secure their food production more than the growing population (Regmi & Weber, 2000). The adoption of technology in agriculture has a huge potential to resolve some issues in agriculture such as limited use of land for agricultural activities, low productivity, disease and pest infestation and lack of labour (Dardak, 2016). Thus, this paper critically analysed the issues and challenges that affected the usage of IT in agribusinesses.

The second stage is data collection that involved identifying the target and choosing the accessible population (Cooper, 1982). In this stage, the researchers determine the findings that previous concern research regarding the chosen topic and problem and the population of people that the researchers are targeting (Cooper, 1982; Russell, 2005). The example of the accessible population to obtain information included selected database, years of publication, subject headings and methodological aspects. An inclusion and exclusion criteria were being developed to create a valid set of considerable trial and reliability of the system (Randolph, 2009). In the present study, a few inclusion and exclusion criteria have been determined. Table 2 below shows the inclusion and exclusion criteria that have been selected for the literature review processes.

Table 2: Inclusion and Exclusion Criteria of Articles Selection for Data Collection

No.	Description	Inclusion Criteria	Exclusion Criteria
1.	Language	Articles published in English and Malay	Non-English or non-Malay papers published in other languages
2.	Participant's selected	The participants selected could be included as farmers, traders, large-scale commercial enterprise, government agencies, non-government agencies and any relevant participants that related to the topic of research	Participants that do not relate to the topic of research. Example: Oil and gas industry
3.	Methodological aspects	All methodological aspects are accepted (qualitative, quantitative and mixed mode)	Papers with the unknown and unclear method are excluded
4.	Electronic sources	An authorised database such as Emerald Insight, Science Direct, Research Gate, Wiley Online, Scopus, Web of Science, Google Scholar and others database that has been authorised by the academic institution Additionally, the researchers also searched websites of organisations that known to be related to agriculture such as the Food and Agriculture Organization of the United Nations (FAO).	Non-authorised and unknown resources of papers are excluded
5.	Major discipline (subject)	'Agriculture productivity' OR 'Information Technology' OR 'Human Resources' OR 'Infrastructure' OR 'Organisation'	Any paper that was not conducted related to the subject
6.	Years of publication	There is no range of years (any years of publication could be included and selected but priority on recent articles)	Any paper without years of publication and sources

7. Keywords	Concern on the related topic especially to the terms of farmers or agriculture or agriculture productivity or information technology or infrastructure or human resources or organisation	Any paper with the absence of keywords needed in the body of their context
8. Geography	Focus on article of developing countries that discuss on issues and challenges of IT in agriculture	Any paper that focus on issues and challenges of developed countries

Data evaluation is the third stage in literature processes that extract and evaluate the information of the articles that met the inclusion criteria. This stage extracts research outcomes data from each article and determines how to merge those outcomes (Randolph, 2009). During this phase, the researchers critically evaluate whether the data elements remain notable for the study (Russell, 2005). 14 journal articles are finalised to be selected and included for which followed to the criteria. The selected articles are presented later in the finding's section.

The fourth step involved data analyses and gave an interpretation of data collected. Cooper (1982) defines this phase as the separation of selected synthesised data into a clear statement about the research problem. In this article, all selected articles included in the study are categorised into three themes based on the issues highlighted. To identify different topics related to the issues and challenges of IT usage in agriculture, three themes were discovered along with data analysis processes: infrastructure, people, and organisation. These themes were summarised and presented with more details in the finding's section. These three themes are designated based on the reliable data in the selected articles that showed multiple repetitive highlighted data in common.

This last stage determined which information is more important and will be presented (Randolph, 2009). According to Cooper (1982), the importance of public presentation is due to the accumulation of knowledge with suggested format including introduction, methods, results and discussion sections (Cooper, 1982). Although the data collection method is considered systematic and organise, the researchers still cannot avoid research limitations that obstructed these five phases run smoothly. While

finishing this article, some limitations occurred during the stages of literature review, particularly in data collection and data evaluation stages. Firstly, the search keywords selected was too general and likely to be oversimplified for a systematic data collection. Secondly, a limited database was used in the data collection phase, which is only reliable to Emerald Insight, Science Direct, Research Gate, Wiley Online, and Google Scholar. This limitation also frequently resulted from the restriction accessed in some database where the researchers unable to access some articles that might benefit to the study. While working on data collection, the researchers found several articles that were convenient to the working but unfortunately being ignored due to unknown sources and unpublished paper as stated in the exclusion criteria. The last limitation is there might be over-reliance on specific sources and authors. The over-reliance on specific sources may lead to the repeated discussion within the writing of the article. Insufficient recent studies regarding the issues and problems might also cause repetitive discussion, especially in the findings matter.

FINDINGS AND DISCUSSION

Eligible papers were short-listed and full-text articles were accessed through the articles that fulfill the inclusion criteria. 14 articles were analysed and presented as the results of the problems formulated before which related to information technology and agriculture production. The selected articles resulted to three main issues and challenges in the usage of IT in terms of the agriculture sector as well as agribusiness. These three main themes of the issues and challenges were categorised as infrastructure, people and organisation. Figure 1 shows the illustration of three themes that have being analysed. The systematic review allowed the researchers to provide a basic understanding of the relationship between the problems developed in the study with the findings found as a response to the problems stated. The following paragraph discusses and elaborates the three themes identified from the review. The summary of the findings is presented in Table 3. The articles are categorised by the country of the study area and the findings found in common.

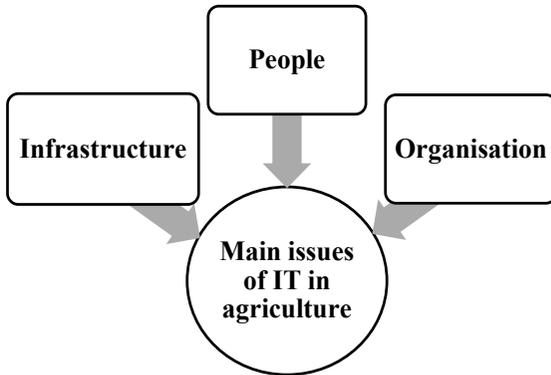


Figure 1: The Main Issues and Challenges Usage of IT in Agriculture

Infrastructure

Past literature published by Jochimsen (1966) defined infrastructure as a system that sum of material, institutional, personal facilities and data available to the economic agents to contribute to the inputs in the case of allocation of resource and resulted in the integration and maximum level of economic activities (Buhr, 2003). In other words, the infrastructure acted as a system of interaction in economic agents and ensuring a linkage within production and consumption phases (Baskakova & Malafeev, 2017). There are several categories of infrastructure such as institutional infrastructure, personal infrastructure and material infrastructure (Buhr, 2003). In term of agriculture, infrastructure is known to be an important key element for the success of agriculture development programmes (Eswaran *et al.*, 1995). This statement also agreed by Patel (2010), that infrastructure leads to expansion of markets, economies of scale and also improvement in factor market operations. Infrastructure in agriculture as basic can be classified into three specifications which are capital intensive, capital extensive and institutional infrastructure (Wharton, 1967). Capital intensive infrastructure includes transportation, water for irrigation, electricity, telecommunication and information while capital extensive closely related to the extensive workers or agriculture researcher and lastly, institutional infrastructure consists of formal and informal institutions such as government stability and law and order (Wharton, 1967). Agriculture infrastructure can be categorised under broad-based categories such as (i) input based infrastructure (seed, fertiliser, pesticides, farm equipment and machinery);

(ii) resource-based infrastructure (water, irrigation, farm power or energy); (iii) physical infrastructure (road connectivity, transport, storage, processing, preservation, etc.); (iv) institutional infrastructure (agricultural research, extension and education technology, information and communication services, financial services and marketing, etc. (Patel, 2010). A discussion from a research paper by Munyanyi (2010), Gajigo and Lakuma (2011) has stated that infrastructure is the major aspect of agricultural productivity growth. The authors also listed three main agricultural infrastructures: road network irrigation technology and post-harvest storage technology. Along with it, a well-designed IT infrastructure in agriculture development will help to improve the availability and transparency of agriculture information and lower agricultural trade transaction cost (Bojnec & Ferto, 2011). For example, the development of physical infrastructures such as farm recording Application Software and Personal Digital Assistant (PDA) in Nigeria helps to keep data entry for field records and maintains the smoothness of operations (Igwe *et al.*, 2019). Unfortunately, many developing countries are struggling with access to IT infrastructure in their farming businesses. A case study in Zimbabwe shows that there is lack of capacity by the irrigation industry, equipment suppliers and contractors to provide services and a lack of post-harvest infrastructure in the rural areas and affect the long-term sustainable food production (Munyanyi, 2010). Similarly, a study by Žmija *et al.* (2020) found that in both European and African countries, nearly half of the respondents do not operate their production solely on their land and this statement has proved that farmers are struggling to access land, thus causing them to run their farm production on lease land (Žmija *et al.*, 2020). These issues also occur in Iran and Guatemala where poor infrastructure and weak strategic coordination are unable to respond to farming issues such as lack of available land and low quality of land (Dale *et al.*, 2020; Hamedanlou, 2009). Limited access to the Internet as well as telecommunication because of the lack of information technology infrastructure and development has led to data redundancy and duplication of work (Kale *et al.*, 2015). Those studies have shown that awareness of current trend technology knowledge and willingness of farmers to adopt IT is crucial to achieving higher agriculture production through development of infrastructure. In conclusion, the researchers conclude that the major challenges of IT in this section are the lack of infrastructure development and insufficient access to IT infrastructures.

People

Human capabilities can be defined as human resource management that plays a crucial role in achieving organisational goals and converts the resources in an organisation into the ultimate output (Adeel *et al.*, 2017). According to Guest (1987), there are four key dimensions to human resource management: commitment, flexibility, quality, and integration as a contribution that could be expected from an employee to the organisation. Human resource development is considered as a force for optimising human growth, organisational effectiveness and national development through skill enhancement in the workforce (Rivera, 1995). A scholar has examined people as the factors that affecting the flexibility and adaptability that would lead to the success of an organisation (Khatri, 1999). FAO defined that human resources are one of the key success factors in agricultural development, particularly in production, processing and distributions of food crops and commodities (FAO, 1986). Rivera (1995) also agreed that new technologies and better on-farm adoption depend on the people factor in terms of agriculture. Wright *et al.* (2003) mentioned that growth comes from attracting, retaining, and developing the people within the industry, supporting research, education, and other service infrastructure. In this issue, IT is directly involved with the major participant of farming business, the farmer's society, as the main actors in the agriculture sector. A previous study by Awais and Khan (2014) shows that the negative perception of tribal farmers towards adopting IT in farming processes is a significant barrier to improving their agriculture productivity. This study proved that there is lacked young generations participation in farming processes and the low educational status of family member's that affected the development of IT in agriculture (Awais & Khan, 2014). This study has shown that awareness of current trend technology knowledge and willingness of farmers to adopt IT is crucial to achieving higher agriculture production. Lopez and Valdes (2000) argued that in the matter of knowledge, there is a small return on education investment and young generation tends to migrate to urban areas instead of inherited their family farming businesses (Lopez & Valdes, 2000). Thus, Mozumdar (2012) strongly stand with his opinion that education, training and extension services are necessary elements for developing and increasing the knowledge of farmers to help them adapt to new technologies properly and make sufficient use of limited resources to achieve increasing in agriculture productivity (Mozumdar, 2012). Similarly, a study in Malaysia

and Thailand also bring out that weak perception of technologies, low education of farmers and limited knowledge among people in business as the non-adoption factors and challenges in the usage of IT for agricultural business (Mat Lazim *et al.*, 2020; Faysse *et al.*, 2022). Low skills, moderate interest in farming and knowledge of young farmers has resulted in a lack of technology development that caused a reduction in farmer's land ownership, land reform and land regeneration (Anandita & Patria, 2016). A case study in Guatemala and Thailand represented low rate interest in adult and failure to attract a new generation of farmers, hence led to labour constraints (Dale *et al.*, 2020; Faysse *et al.*, 2022). Past works of literature found key challenges in adopting IT to the agriculture industry were increased due to sophisticated software with advanced human capital requirements and the needs for ongoing end-user extension training to enhance farmers (Saidu *et al.*, 2017). This theme generally emphasise the importance of training and knowledge among farmers to manage and utilise any kind of IT usage in agriculture procedures and determine the points as challenges that incurred for adoption and usage of IT in agriculture.

Organisation

An organisation is a formal structure of organised coordination involving two or more people to achieve goals by authority relationship and a division of labour (Gitman *et al.*, 2018). Certain elements closely related to the organisation and works within this group which known as stakeholders. Stakeholders can be defined as an individual that has something to do with business, internal or external because of the impact and the potential to the organisation, such as employees, investor, supplier, government, society, creditors, and the customer of businesses (Benn *et al.*, 2016). A business must have a good quality of organisational values that integrated the personality of a company by reflected values of individuals, behavioural patterns, influencing relationship within the organisation and convince its customers, suppliers and other stakeholders (Gorenak & Kosir, 2017). In agribusiness, interrelated subsectors work together to provide goods and services to consumer worldwide, involving foods as an economic good with distinctive cultural, institutional, and political aspects to developed economic environment and business processes (Gunderson *et al.*, 2014). The study agreed that individuals such as genetics and seed stock firms, input suppliers, agricultural producers, merchandises or first

handlers, processors, retailers and consumers as major participants that contributed to this nature of businesses (Gunderson *et al.*, 2014). In term of agriculture, organisation issues also might conclude agriculture policy and relationship with agriculture stakeholders. For example, in Kenya, an association of Kenya Agricultural Commodity Exchange developed Mobile Phone Short Messaging Service (SMS SOKONI) that allows all farmers to explore market information using a mobile phone. This proves that organisation relation with an external individual is dominant in developing IT of agriculture (Muriithi *et al.*, 2009). A study in Nigeria discovered that government programmes such as the Agricultural Development Programme and the Directorate of Food, Roads and Rural Infrastructures had proved a significant positive impact on reducing poverty, particularly in terms of agricultural productivity (Nwachukwu & Ezech, 2007).

Additionally, government policy also determines the direction agricultural productivity as government policies and programmes were compiled to assist farmers in terms of input and output support as well as technical and financial support to ensure productive agriculture productivity to fulfill current and future demands (Lencucha *et al.*, 2020). Even though policies were designed to assist farmers and entities in the farming business, the policies also can be debated within the sectors with rising issues in terms of the sector's political importance (Barichello & Patunru, 2009). Zimbabwe is dealing with the struggle to access infrastructure financing, high cost of land and limited market access, together with a related study in Europe and African countries which having difficulties accessing subsidies, credit and finance as the farmer's lack of knowledge on how to draft and build business plans for financial section (Munyanyi, 2010). A case study in Iran expressed the weakness of their government policy when agriculture production operated at a low level as the available policies are weak, facing high risk in investment and having insufficient content for rural society (Hamedanlou 2009; Lashgarara *et al.*, 2011). Southeast Asia countries also affected to these issues. In Philippines, low agricultural productivity has become a bigger challenge in managing the demands of the country where some of the challenges that had to face by the Philippines are limited access to credit and agricultural insurance, minimal support for research and development and incomplete agriculture reform programme implementation (Brown *et al.*, 2018). Low teaching capacities and inadequate resources and funds from government policies also dragged Malaysia into this issue (Mat Lazim *et*

al, 2020). This theme has shown the importance of relationship within the internal and external of an organisation to achieve business goal's and give significant benefits to other related parties in the field.

Table 3: Summary of Issues and Challenges of IT in Agriculture in Terms of Infrastructure, People and Organisation

Authors/ (Year)	Country	Infrastructures	People	Organisation
Katarzyna Zmija, Arlindo Fortes, and Moses Nganwani Tia (2020); Hannah Ritchie (2022)	Europe & Africa	Limited access to uncultivated land due to lack of appropriate infrastructure	Low rate of labour productivity	<ul style="list-style-type: none"> • Struggle to access subsidies, credit and finance • Struggle to access infrastructure financing
Virginia H. Dale, Keith L. Kline, Santiago Lopez-Ridaura, Sarah E. Eichler, Ivan Ortiz-Monasterio and Luis F. Ramirez (2020)	Guatemala	Lack of available land, low quality of land and poor connectivity infrastructure	Lack of interest in the adult family to farming business - labour constraints	Low access to financial products and credit
Hamedanlou (2009); Farhad Lashgarara, Roya Mohammadi and Maryam Omid (2011)	Iran	Poor infrastructure and weak strategic coordination	Lacked in human resources capacity	Weak of available policies, lack of content in rural society and risk of investment
M. Faiz Syuaib (2016); Della Ayu Anandita and Kinanti Zukhrufijannah Patria (2016); Iqbal Rafani and Tahlim Sudaryanto (2021)	Indonesia	Rural infrastructure suffers a long-term decline in investment including roads, rail and sea transport, irrigation, and electricity provision	Low labour productivity in agriculture sector	Lacked skills and knowledge for the young generation

Nicolas Faysse, Kassirin Phiboonn and Man Purotaganon (2022)	Thailand	Farms generally small and less access to irrigation water	Failure to attract a new generation into farming and ageing farming population	Absence of medium training and education for farmers and scientists
Rabiah Mat Lazim, Nazmi Mat Nawi, Muhammad Hairie Masroon, Najidah Abdullah and Maryani Mohammad Iskandar (2020)	Malaysia	Insufficient necessary infrastructure to transforms to digital access	Weak perception of technologies, low education of farmers and limited knowledge	Low teaching capacities and inadequate resources and funds
Watson Munyanyi (2013)	Zimbabwe	Lack of capacity by the irrigation industry, equipment suppliers and contractors to provide services and lack of post-harvest infrastructure	Lack of young farmers participants	Struggle to access infrastructure financing
Ernesto O. Brown, Fezoi Luz C. Decena and Reynaldo V. Eborá (2018)	Philippine	Low farm mechanism, inadequate postharvest facilities and inadequate irrigation	Ageing farmers – lacked young participants	Limited access to credit and agricultural insurance, minimal support for research and development, weak extension service and incomplete agriculture reform program implementation
Awais and Khan (2014); Shreya Anand, Satya Prakash, A.K Singh and Sudhamini Yedida (2020)	India	The problem of irrigation, soil conservation, and soil testing services	Low level of education and lack of communication	Lacked government participant to advance agricultural sector and infrastructure

RESEARCH CONTRIBUTIONS

There are two expected contributions from this article that can be classified into theoretical and practical contributions. This article could contribute in term of theoretically to academic and government policy. The discussion would directly provide a depth scope of identifying issues and challenges of IT application in the agriculture sector. For a bigger impact, this article might also lead and guide government institutional or related organisation to discover the challenges of IT development in agriculture that occurs in the current state to reach the vision of preparing sufficient foods for upcoming demands in 2050 (FAO, 2017). These data could also be reviewed to develop a new theory or policy that would assist farmers in need. In terms of practical contributions, this article would supply inputs for educating farmers and other related parties in analysing issues and challenges of farming businesses regarding IT and acknowledging barriers that farmers should overcome. Furthermore, it also could help existing and potential small agriculture business to be more skilled in improving resources management and at the same time learn new knowledge and skills for better productivity thus directly contribute to the economic development of the nation's food production. Future research should focus on articles derived from mixed method study to understand how the method will be used within this scope of study and should be conducted by using different databases.

CONCLUSION

Despite the importance of farming businesses in a country, unfortunately, the agriculture sector has not been emphasised due to resource limitation and agriculture technology usage issues. This article has collectively outlined and pointed out the major issues and challenges of IT in the agriculture sector using three aspects: infrastructure, people, and organisation. The infrastructure section has shown that poor infrastructure in the farming area discourages implementing and applying IT into farming processes. The issue among people reviewed that farmer's perspective and understanding towards the needs of IT in agriculture business is crucial to develop any skills on IT to the farm. The organisation aspect evaluates some management issues such as financing within internal and external related parties as well as development of government policy. This article has contributed to the identification and

analysing of the barriers and limitation that should be overcome by farmer's society and any related parties in the agriculture sector.

In conclusion, to meet the needs of the future as the human population is overgrowing, all farming businesses must be able and willing to adapt to new changes using advanced technology as the main elements in their farming management. All issues in managing IT and IT-related resources in agriculture production can best be solved by adopting IT into the processes of food production, farm management and utilising the available human capabilities. Each leading key player should work together and play their roles to ensure the sustainability of food production in their nation.

ACKNOWLEDGEMENT

The authors would like to acknowledge the financial and technical support for this project provided by Universiti Sultan Zainal Abidin (UniSZA), under the LabMat Research Grant (UniSZA/2020/LABMAT/02).

REFERENCES

- Adeel, A., Syed, N., and Ismail, K. A. (2017). Human resource management in agribusiness. In A. Ghafoor (Ed.), *Agribusiness Management in Pakistan* (pp. 173–196). University of Agriculture, Faisalabad (Pakistan)
- Anand, S., Prakash, S., Singh, A. K., and Yedida, S. (2020). Access and availability of ICT tools used by farmers for crop practice in Bihar, India. *International Journal of Current Microbiology and Applied Sciences*, 9(5), 1146-1150. <https://doi.org/10.20546/ijcmas.2020.905.125>
- Anandita, D. A., and Patria, K. Z. (2016). Agriculture challenges: Decline of farmers and farmland study from Indonesian family life survey. *Jurnal Ilmu Ekonomi Dan Pembangunan*, 16(1), 48–53. <https://doi.org/10.20961/jiep.v16i1.2314>
- Attaran, M. (2003). Information technology and business-process redesign. *Business Process Management Journal*, 9(4), 440–458. <https://doi.org/10.1108/14637150310484508>

- Awais, M., and Khan, N. (2014). Adoption of new agricultural technology: A case study of Buksa Tribal farmers in Bijnor district, Western Uttar Pradesh, India. *International Journal of Agriculture, Environment and Biotechnology*, 7(2), 403. <https://doi.org/10.5958/2230-732x.2014.00261.7>
- Ayaz, M., Member, S., and Member, M. A. S. (2019). Internet-of-things (IoT) based smart agriculture: Towards making the fields talk. *IEEE Access*, 7, 129551–129583. <https://doi.org/10.1109/ACCESS.2019.2932609>
- Barichello, R., and Patunru, A. (2009). Agriculture in Indonesia: Lagging performance and difficult choices. *Agriculture and Applied Economics Association*, 24(2), 37–41.
- Baskakova, I. V., and Malafeev, N. S. (2017). The concept of infrastructure: Definition, classification and methodology for empirical evaluation. *Journal of New Economy*, 3(71), 29–41. <https://doi.org/10.29141/2073-1019-2017-15-3-3>
- Benn, S., Abratt, R., and Leary, B. O. (2016). Defining and identifying stakeholders: Views from management and stakeholders. *South African Journal of Business Management*, 47(2), 1–11. <https://doi.org/http://dx.doi.org/10.4102/sajbm.v47i2.55>
- Bojnec, S., and Ferto, I. (2011). Information and communication infrastructure development and agro-food trade. *Agricultural Economics (AGRICECON) - CZECH*, 57(2), 64–70. <https://doi.org/10.17221/82/2010-AGRICECON>
- Brown, E.O, Decena, F.L.C., and Ebor, R.V. (2018). The current state, challenges and plans for Philippine agriculture. Food and Fertilizer Technology Center for Asian and Pacific Region (FFTC-AP). <https://ap.ffc.org.tw/article/500>
- Buhr, W. (2003). What is infrastructure? Economic discussion papers 107-03. University of Siegen, Faculty of Economics, Business Informatics and Business Law

- Cooper, H. M. (1982). Scientific guidelines for conducting integrative research reviews. *American Educational Research Association*, 52(2), 291–302.
- Cooper, H. M. (1988). Organizing knowledge syntheses : A taxonomy of literature reviews. *Knowledge in Society*, 1, 104. <https://doi.org/10.1007/BF03177550>
- Cooper, R. G. (2008). Perspective: The stage-ate® Idea-to-Launch Process-Update, What's New, and NexGen Systems. *Journal of Product Innovation Management*, 25(3), 213–232. <https://doi:10.1111/j.1540-5885.2008.00296.x>
- Dardak, R. A., and Adham, K. A. (2014). Transferring agricultural technology from government research institution to private firms in Malaysia. *Procedia - Social and Behavioral Sciences*, 115(Icics 2013), 346–360. <https://doi.org/10.1016/j.sbspro.2014.02.441>
- Dardak, R.A. (2016). The development of agro-based SMEs through technology transfer from government research institution. Food and Fertilizer Technology Center for Asian and Pacific Region (FFTC-AP), <https://ap.ffc.org.tw/article/1070>
- Dale, V. H., Kline, K. L., Santiago L. R., Eichler, S. E., Ivan O. M. and Ramirez, L. F. (2020). Towards more sustainable agricultural landscapes: Lessons from Northwestern Mexico and the Western Highlands of Guatemala. *Futures*, 124, 102647. <https://doi.org/10.1016/j.futures.2020.102647>
- Duangsuwan, S., and Maw, M. (2020). Development of soil moisture monitoring by using IoT and UAV-SC for smart farming application. *Advances in Science, Technology and Engineering Systems Journal*, 5(4), 381–387. <https://doi.org/10.25046/aj050444>
- Dutonde, S. R. (2018). Modern agriculture: Concept and it's benefit. *International Journal of Current Engineering And Scientific Research (IJCESR)*, 5(1), 222-227

- Ellison, B., and Kalaitzandonakes, M. (2020). Food waste and Covid-19: Impacts along the supply chain. *farmdoc daily* (10), 164, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, September 10. <https://farmdocdaily.illinois.edu/2020/09/food-waste-and-covid-19-impacts-along-the-supply-chain.html>
- Eswaran, H., Virmani, S. M., and Abrol, I. P. (1995). Issues and challenges of dryland agriculture in southern Asia. *Agriculture and Environment: Bridging Food Production and Environmental Protection in Developing Countries*, 60, 161–180. <https://doi.org/10.2134/asaspecpub60.c9>
- Faysse, N., Phiboon K. and Purotaganon, M. (2022). Which pathway to address interrelated challenges to farm sustainability in Thailand? Views of local actors. *Regional Environmental Change*, 22(11), <https://doi.org/10.1007/s10113-021-01871-2>
- FAO. (1986). The state of food and agriculture. World and regional reviews financing agricultural developments. Food and Agriculture Organization of the United Nations
- FAO. (2017). The future of food and agriculture: Trends and challenges. Food and Agriculture Organization of the United Nations
- Fróna, D., Szenderák, J., and Harangi-Rákos, M. (2019). The challenge of feeding the world. *Sustainability*, 11(20), 5816 – <https://doi:10.3390/su11205816>
- Gajigo, G., and Lukoma, A. (2011). Infrastructure and agricultural productivity in Africa. Market Brief, Chief Economist Complex. African Development Bank Marketing Brief
- Gall, M. D., Borg, W. R., and Gall, J. P. (1996). *Education Research: An Introduction*. New York: Longman Publishers
- Gitman, L. J., McDaniel, C., Shah, A., Reece, M., Koffel, L., Talsma, B., and Hyatt, J. C. (2018). Introduction to business. *Journal of the American Statistical Association*, 53(281), 215-217. <https://doi.org/10.2307/2282585>

- Gorenak, M., and Kosir, S. (2017). The importance of organizational values for organization. In Management, Knowledge and Learning International Conference 2012, 563–569
- Guest, D. (1987) Human resource management and industrial relations. *Journal of Management Studies*, 24, 503- 521. <http://dx.doi.org/10.1111/j.1467-6486.1987.tb00460.x>
- Gunderson, M., Boehlje, M., Neves, M., and Sonka, S. (2014). Agribusiness organization and management. In *Encyclopedia of Agriculture and Food Systems* (Vol. 1, pp. 51–70). <https://doi.org/10.1016/B978-0-444-52512-3.00117-0>
- Hamedanlou, M. (2009). Obstacles and challenges of developing rural ICT centers in Iran. *Managers of Iran*. Available on: <http://www.modiriran.ir/modules/article/view.article.php/597>
- Igwe, J. S., Onu, F. U., and Agwu, C. O. (2019). A local ICT application tools for agricultural development in Nigeria. *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, 8(8), 1187–1192
- Ismail, N., Khusahry, M., and Yusuff, M. (2009). The modernized and higher technology agriculture of Malaysia: Development of livestock industry. In International Conference on Malaysia: Malaysia in Global Perspective, 27-28 September 2009, Cairo University, Egypt, 381–395.
- Jochimsen R (1966). *Theory of the Infrastructure: Fundamentals of the Market Economy Development*. Tubingen, Germany: JCB Mohr
- Kale, R. B., Rohilla, P. P., Meena, M. S., and Wadkar, S. K. (2015). Information and communication technologies for agriculture knowledge management in India. *Journal of Global Communication*, 8(1), 16–22. <https://doi.org/10.5958/0976-2442.2015.00002.6>
- Khatri, N. (1999). Emerging issues in strategic HRM in Singapore. *International Journal of Manpower*, 20(8), 516–529. <https://doi.org/10.1108/01437729910302714>

- Lashgarara, F., Mohammadi, R., and Najafabadi, M. O. (2011). ICT capabilities in improving marketing of agricultural productions of Garmsar Township, Iran. *Annals of Biological Research*, 2(6), 356–363
- Lencucha, R., Pal, N. E., Appau, A., Thow, A. M., and Drope, J. (2020). Government policy and agricultural production: A scoping review to inform research and policy on healthy agricultural commodities. *Globalization and Health*, 16(1), 1–15. <https://doi.org/10.1186/s12992-020-0542-2>
- Lopez, R., and Valdes, A. (2000). *Rural Poverty in Latin America: Analytics, New Empirical Evidence, and Policy*. London: Macmillan Press
- Mat Lazim, R., Mat Mawi, N. and Masroon M.H. (2020). Adoption of IR4.0 in agricultural sector in Malaysia: Potential and challenges. *Advances in Agricultural and Food Research Journal*, 1(2), Article ID: a0000140., <https://doi.org/10.36877/aafrj. a0000140>
- Milovanović, S. (2014). The role and potential of information technology in agricultural improvement. *Economics of Agriculture, Institute of Agricultural Economics*, 61(2), 471–485. <https://doi.org/10.22004/ag.econ.175295>
- Mozumdar, L. (2012). Agricultural productivity and food security in the developing world. *Bangladesh Journal of Agricultural Economics*, 35(1/2), 53–69. <https://doi.org/10.22004/ag.econ.196764>
- Munyanyi, W. (2010). Agricultural infrastructure development imperative for sustainable food production: A Zimbabwean perspective. *Russian Journal of Agricultural and Socio-Economic Sciences*, 12(24), 13–21. <https://doi.org/10.18551/rjoas.2013-12.02>
- Muriithi, A. G., Bett, E., and Ogaleh, S. A. (2009). Information technology for agriculture and rural development in Africa: Experiences from Kenya. *Conference on International Research on Food Security, Natural Resource Management and Rural Development*, 6(8), 20–25

- Nwachukwu, I. N., and Ezeh, C. I. (2007). Impact of selected rural development programmes on poverty alleviation in Ikwuano LGA, Abia State, Nigeria. *African Journal of Food Agriculture Nutrition and Development*, 7(5). <https://doi.org/10.4314/AJFAND.V7I5>
- Patel, A. (2010). Infrastructure for agriculture and rural development in India: Need for a comprehensive program and adequate investment. In *FinDev Gateway* (pp. 1–17)
- Pawlak, K. and Kołodziejczak, M. (2020) The role of agriculture in ensuring food security in developing countries: Considerations in the context of the problem of sustainable food production. *Sustainability*, 12, 5488. <https://doi.org/10.3390/su12135488>
- Praburaj, L. (2018). Role of agriculture in the economic development of a country. *Shanlax International Journal of Commerce*, 6(3), 1–5. <https://doi.org/10.5281/zenodo.1323056>
- Rafani, I. and Sudaryanto, T. (2021). Indonesian agricultural labor policy: Issues and challenges. Food and Fertilizer Technology Center for the Asian and Pacific Region (FFTC-AP). Retrieved on 4 April 2022 from <https://ap.ffc.org.tw/article/2592>
- Randolph, J. (2009). A guide to writing the dissertation literature review. *Practical Assessment, Research and Evaluation*, 14(13). <https://doi.org/10.7275/b0az-8t74>
- Ranganathan, J., Waite, R., Searchinger, T., and Hanson, C. (2018). How to sustainably feed 10 billion people by 2050, in 21 charts. World Resources Institute. <https://www.wri.org/insights/how-sustainably-feed-10-billion-people-2050-21-charts>
- Regmi, P. P., and Weber, K. E. (2000). Problems to agricultural sustainability in developing countries and a potential solution: Diversity. *International Journal of Social Economics*, 27(7–10), 788–801. <https://doi.org/10.1108/03068290010335226>

- Ritchie, H. (2017). How much of the world's land would we need in order to feed the global population with the average diet of a given country? Our World in Data - Agricultural Land by Global Diets. <https://ourworldindata.org/agricultural-land-by-global-diets>
- Ritchie, H. (2022). Increasing agricultural productivity across sub-Saharan Africa is one of the most important problems this century. Our World in Data - Africa Yields Problem. <https://ourworldindata.org/africa-yields-problem>
- Rivera, W. M. (1995). Human resource development in the agriculture sector: Three levels of need. *International Journal of Lifelong Education*, 14(1), 65–73. <https://doi.org/10.1080/0260137950140106>
- Roukh, A., Fote, F. N., Mahmoudi, S. A., and Mahmoudi, S. (2020). Big data processing architecture for smart farming. *Procedia Computer Science*, 177, 78–85. <https://doi.org/10.1016/j.procs.2020.10.014>
- Russell, C. L. (2005). An overview of the integrative research review. *Progress in Transplantation*, 15(1), 8–13. <https://doi.org/10.1177/152692480501500102>
- Saidu, A., Clarkson, A. M., Adamu, S. H., Mohammed, M., and Jibo, I. (2017). Application of ICT in agriculture: Opportunities and challenges in developing countries. *International Journal of Computer Science and Mathematical Theory*, 3(1), 8–18
- Sharma, N. and Mungarwal, A.K. (2019). Applying modern tech to agriculture. DownToEarth. <https://www.downtoearth.org.in/blog/agriculture/how-big-data-can-boost-agricultural-growth-65932>
- Syuaib, M.F. (2016). Sustainable agriculture in Indonesia: Facts and challenges to keep growing in harmony with environment. *Agricultural Engineering International: CIGR Journal*, 18(2), 170-184. <http://repository.ipb.ac.id/handle/123456789/82045>

- Mitra, T. (2014). Importance of information technology in agricultural reforms. LinkedIn. <https://www.linkedin.com/pulse/20140627095530-308433376-importance-of-information-technology-in-agricultural-reforms>
- Thong, J. Y. L., and Yap, C. S. (1995). CEO characteristics, organizational characteristics and information technology adoption in small businesses. *Omega - The International Journal of Management Science*, 23(4), 429–442. [https://doi.org/10.1016/0305-0483\(95\)00017-1](https://doi.org/10.1016/0305-0483(95)00017-1)
- Tompkins, S. (2020). Getting ready for agriculture 4.0. *The Star*. <https://www.thestar.com.my/opinion/letters/2020/07/16/getting-ready-for-agriculture-40>
- Triantafyllou, A., Sarigiannidis, P., and Bibi, S. (2019). Precision agriculture: A remote sensing monitoring system architecture. *Information (Switzerland)*, 10(348), 26. <https://doi.org/10.3390/info10110348>
- Victoria, A. (2020). Information technology. <https://doi.org/10.13140/RG.2.2.15684.78728>
- Wharton, C.R. (1967). The infrastructure for agricultural growth. In Southworth, H.M. and Johnston, B.J. (ed.), *Agricultural Development and Economic Growth*. Ithaca, N.Y.: Cornell University Press.
- Wright, P. M., Gardner, T. M., and Moynihan, L. M. (2003). The impact of HR practices on the performance of business units, *Human Resource Management Journal*, 13(3), 21–36. <https://doi.org/10.1111/j.1748-8583.2003.tb00096.x>
- Yue, Z. (2009). On definition of farmers and its connotation and particularity in modern agricultural background. *Asian Social Science*, 5(2), 19–23. <https://doi.org/10.5539/ass.v5n2p1>
- Zanella, R. de A., Eduardo, da S., and Albin, L. C. P. (2020). Security challenges to smart agriculture: Current state, key issues, and future directions. *Array*, 8(November), 100048. <https://doi.org/10.1016/j.array.2020.100048>

Žmija, K., Fortes, A., Tia, M. N., Šūmane, S., Ayambila, S. N., Žmija, D., Satoła, Ł., and Sutherland, L. A. (2020). Small farming and generational renewal in the context of food security challenges. *Global Food Security*, 26, 100412. <https://doi.org/10.1016/j.gfs.2020.100412>