The 1st
International Vocational Agriculture Symposium
Volume 1 Nomor 1 April 2026

Determinant Factors Of Digital Agriculture Adoption By Farmers In A Global Perspective : A Systematic Literature Review

Heri Apriyanto, Citra Dewi Anggraeni*
National Research and Innovation Agency of Indonesia

History Article:
- Submit: Juli 2025
- Publish: April 2026

Keyword:
Digital Transformation, Smart Agriculture, Sustainable Agriculture, Technology Adoption, Systematic Review

Corresponding Author:
herieyaja@gmail.com

Abstract
Digital agriculture has emerged as a strategic approach to strengthening food security and promoting environmental sustainability. However, the willingness to adopt digital agriculture technologies among farmers is shaped by multiple interrelated factors. This review addresses a research gap by providing a global evidence synthesis that integrates fragmented findings across regions and develops a taxonomy of digital agriculture adoption determinants. This study examines the determinants of farmers' adoption of digital agriculture technologies from a global perspective through a systematic literature review. Using the PRISMA protocol, 51 articles published between 2020 and 2025 were identified and selected from ScienceDirect, Emerald, and ProQuest databases based on predefined inclusion and exclusion criteria and analysed using a thematic analysis approach. The findings suggest that several factors are frequently reported as drivers of digital agriculture technology adoption, including technological factors (digital literacy, digital infrastructure, and perceived ease of use), organisational factors (investment cost, benefit expectation, socioeconomic status, sociodemographic characteristics, and personal experiences), and environmental factors (government intervention, financial support, and social influences). This review develops a structured taxonomy of digital agriculture adoption factors that can be utilised by policymakers and stakeholders to design inclusive and environmentally sustainable strategies to enhance digital agriculture uptake and strengthen food security.

INTRODUCTION

Following the massive growth of the global population, the demand for food supply has risen significantly around the world. In 2050, about 9 billion people are predicted to inhabit the Earth (Pastrana-Pastrana et al., 2025). It will increase the global food demand by about 70%(Rehman et al., 2022). To prevent food insecurity in the future, the production of food should be increased to keep pace with the population. Consequently, agriculture has transformed into a crucial sector to fulfill the necessity. The success rate of agriculture should be measured to avoid the production losses that threaten food security(Hunt et al., 2021).

To measure the production of food in agriculture, many aspects should be considered. Climate change and environmental sustainability are factors that relate to the agricultural sector. The lack of water, unpredictable climate, drought, flood, and the rise of surface temperatures resulting from climate change have a negative impact on the agricultural sector. Climate change has the potential to reduce agricultural productivity(Das et al., 2025). On the other hand, the agricultural sector also contributes to accelerating this disaster. 11% of greenhouse gas emissions in the world have been generated from agriculture(Rehman et al., 2022). The emissions resulting from agricultural activity can pollute the environment and increase global temperature(Lynch et al., 2021). The massive use of chemicals in agriculture for pesticides or fertilizers is also responsible for climate change(Bibi & Rahman, 2023). So, the problems related to the agricultural sector and global warming may be trapped in a vicious cycle(Lai et al., 2025).

To break the vicious cycle trap, green agriculture should be implemented. Not only does it address the intersection of problems in the agricultural sector, but there are also many benefits in the adoption of green agriculture. First, green agriculture provides efficient and effective agriculture productivity with conservative philosophy and prevent degradation of ecosystems(Nwachukwu, 2023). It has a positive impact on cultivated land quality, and reducing the pollution from agriculture(M. Liu & Liu, 2024). The good quality of land and less polluting direct impacts on productivity and quality in farms. It can be seen in China, the adoption rate of green agriculture, followed by the rise of rice production(C. Li et al., 2021). Second, the practice of sustainable agriculture, supports the preservation of water and soil(Coulibaly et al., 2021). As a result, it can prevent ecosystem disasters such as drought and flood. In addition, In Ghana, the practice of green agriculture can increase the income of farmers and food security(Setsoafia et al., 2022).

The digital technology is highlighted as potential tools to accelerate the implementation of green agriculture(Jiang et al., 2022). The use of Internet of Things (IoT), Artificial Intelligence (AI), blockchain, digital twin and big data as digital technologies are believed to improve efficiency, competitiveness and productivity in agriculture (Zhou et al., 2023). The trend of using technology in agriculture enhances the accuracy of water consumption in agriculture, the calculation of fertilizer use, climate prediction, and analysis of soil conditions. The intention to uptake digital agriculture has broadened around the world. In European countries, the use of digital technology in agricultural sector has been initiated(Bellon-Maurel et al., 2023). Since 1990, digital agriculture has also changed the American agriculture(McFadden et al., 2023). The use of soil maps, data satellites, automated drones, and yield maps improve the quality of decisions made in agriculture. Although faces some challenges, in African countries, the adoption of digital technology has a possibility to boost the productivity in farms(Mhlanga & Ndhlovu, 2023). Hence, the adoption of digital technology in agriculture should be prioritized to address problems faced by farmers and the communities.

However, encouraging farmers to adopt the new technology in agriculture demands specific strategies. Many factors that can drive or prohibit the farmers from using digital technology in their farms(W. Wang et al., 2024). This research will assess previous studies to identify the factors that influence farmers to uptake digital technology. The literature is selected from different countries to provide a global perspective and eliminating bias in the research. So, in the future, the outcome of this research not only can be applied in particular regions, but also it can be used worldwide.

Research question in this study is what are determinants factors that influence farmers to uptake digital agriculture. This paper is divided into four sections. First, introduction elaborates the background of the study and the objectives of the research. Second, the methodology contains the method that is used to address the research question. Third, results and discussion provide the findings. In the last section, there is conclusion and limitations of the research.

RESEARCH METHODOLOGY

A systematic literature review (SLR) was employed to synthesise the previous research and to address the research question of this study. SLR helps develop knowledge and bridge readers to existing knowledge (Lim et al., 2022). This SLR enables the development of structured knowledge and provides a replicable process for evidence synthesis. In this research, the applied method consists of four sections, which are the time period, the process of database selection, the searching process, and the classification process(Fauzi, 2023).

Time Period

This study focuses on articles published in the last five years (between 2020 and 2025) to measure the updated literature in digital agriculture. The rapid development of digital technologies and smart farming justifies the use of the preferred period to ensure the relevance of the findings. The articles that are outside the period were excluded from this study because they may not reflect the current technological and institutional conditions.

Process of database selection

The databases that are identified in this research are from three major databases, which are ScienceDirect from Elsevier (125 articles), Emerald (195 articles) and ProQuest (157 articles). The three databases were selected because they provide the top qualification of peer-reviewed publications in agriculture, technology adoption, rural development, and socio-economic studies. In addition, they index high-impact articles and are widely used in systematic literature review. They are also the most popular and often used in academic and business fields (Tian et al., 2018).

Search Strategy

The process of article selection in this research focuses on gathering peer-reviewed articles related to determinant factors that influence farmers to adopt digital transformation with some search strings. To minimise the risk of missing relevant studies, the search strings were developed using combinations of keywords and Boolean operators. In addition, the synonyms related to determinants, farmers, and digital agriculture were included. As a result, there are 477 articles that are collected based on the specific keywords in this stage from the three databases, as displayed in Table 1.

Table 1. Search strings (Source: Author's own work)

Search string	Databases	Total
("Determinants" OR "factors") AND ("Farmers' Adoption" OR "Farmers' Acceptance") AND ("Digital Agriculture" OR "Smart Farming" OR "digital Farming")	Sciencedirect	125
("Determinants" OR "factors") AND ("Farmers' Adoption" OR "Farmers' Acceptance") AND ("Digital Agriculture" OR "Smart Farming" OR "digital Farming")	Emerald	195
Determinant factors of digital agriculture adoption by farmers	Proquest	157
Total Articles		477

Classification Process with PRISMA Flow

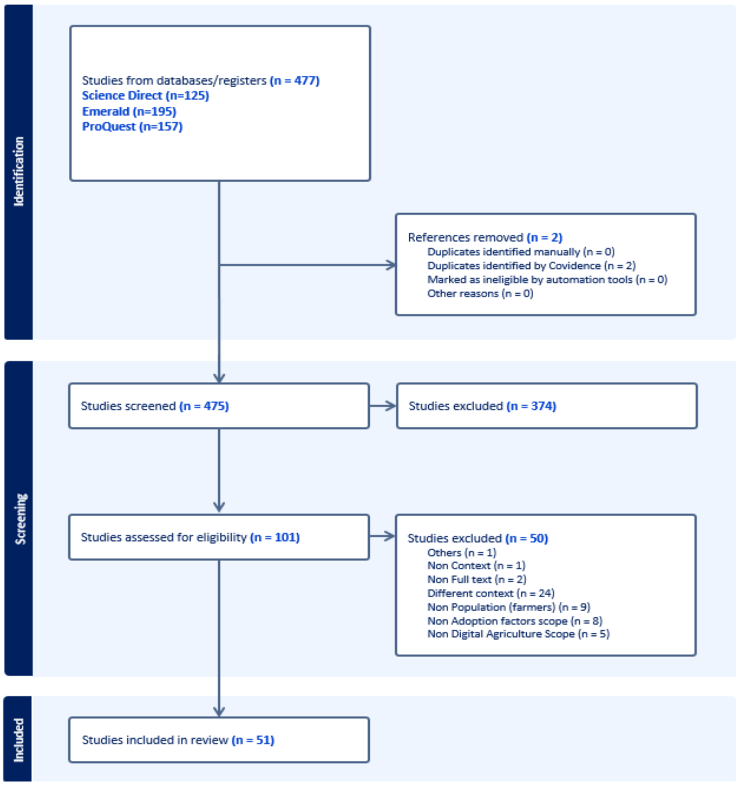

Figure 1. Screening protocol using the Covidence application (Source: Authors own work)

The collected articles are imported into the Covidence application, which can identify the duplication of articles(McKeown & Mir, 2021). This system also helps with screening articles, full-text review, selection process, assessing the quality of the articles, and extracting data(Babineau, 2014). The classification process in this research follows the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) protocol that is adopted by the Covidence application (Figure 1). PRISMA promotes transparency and accuracy based on quality for validity and evidence for decision making(Basenach et al., 2023).

The screening stages were as follows:

- Initial records identified: 477 articles
- Duplicates removed: 2 articles
- Records screened: 374 articles excluded and 101 articles included
- Records assessed for eligibility: 50 articles excluded
- Final articles included in the review: 51 articles

Eligibility Criteria

The inclusion criteria were:

- Peer-reviewed journal articles with full text available.
- The topic focuses on determinant factors of digital agriculture among farmers.
- The articles written in English.

The exclusion criteria were:

- Reports, books, theses, dissertations, and book chapters.
- Articles not related to adoption behaviour,
- The articles with no English language

Also, the process of formulation of research questions uses PICOC as follows:

- **P**opulation: farmers.
- **I**ntervention: Determinant factors that influence digital agriculture adoption.

- **C**omparison: Farmers who adopt digital agriculture and farmers who hesitate to adopt the tools.
- **O**utcome: Improve the adoption rate of digital agriculture by farmers.
- **C**ontext: digital agriculture implementation in a global perspective.

Quality Appraisal

During the full-text review stage, quality assessment was conducted to ensure the inclusion of studies with adequate methodological quality. The evaluation process was based on the clarity of research objectives, data collection method, relevance to the topic, and methodological severity. Articles that were not directly related to the topic or lacked empirical evidence were excluded from the final analysis.

Data Extraction

A structured data extraction form was developed based on key information from selected articles. Information related to objectives and key findings was also documented to support further analysis. The extraction process was conducted to ensure consistency and transparency in collecting relevant information from selected studies. All extracted data were organised into a table to facilitate comparison and identify patterns in the determinants. This structured process also helped to minimise bias and to ensure the relevant variables required for subsequent analysis were consistently captured.

Bibliometric Mapping Using VOSviewer

Bibliographic mapping (Figure 2) is essential to narrow the investigation process. From the map, some clustering words can be used to assemble the determining factors that were analysed in the next process. VOS viewer software has been used to produce the map. Vos is a software that is commonly used to identify patterns and co-occurrence of keywords(Hammouti et al., 2025). Author keywords from the selected studies were exported and analysed using the co-occurrence analysis with a minimum threshold of three to generate the network map. The resulting clusters were used to identify dominant themes and supported the classification of determinants.

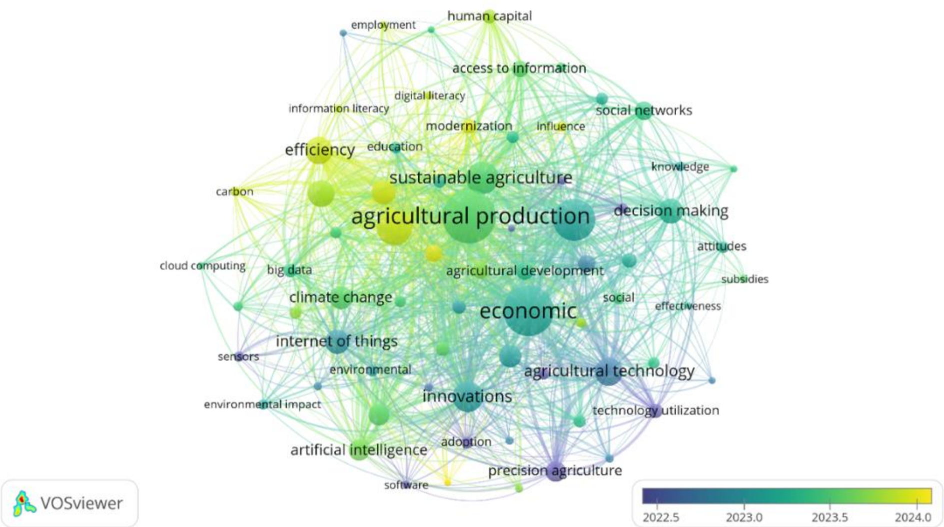

Figure 2**.** Bibliographic mapping using VOS viewer (Source: Author’s own work)

Thematic Analysis and TOE Classification
To develop a taxonomy of digital agriculture adoption determinants, the TOE framework was utilised as the analytical lens. The TOE framework is a widely used holistic framework for explaining technology adoption(Bany Mohammad et al., 2022). First, recurring factors across the selected articles were grouped into themes. Then, these themes were classified into the TOE framework to provide a theory-driven interpretation. The three dimensions of the TOE framework are technological, organisational, and environmental factors.

RESULTS AND DISCUSSION

Articles distribution

The 51 selected articles from the literature review analysis section are described according to the rate of publication, data collection method, region setting, type of farm and title of journals as follows:

a. Publications trends

From the 51 articles, according to Scimago, more than 80 per cent of the articles are published in Q1-indexed journals. The rest of them are indexed in Q2 indexed journals (9,8%), and 3,9 % of articles are unranked based on Scimago. In Table 2 below, it can be observed that most articles were published in 2024 (19) and 2023 (10).

Table 2. The rate of publications (Source: Author's own work)

Rating (Scimago)	Publish Year						Total	%
	2020	2021	2022	2023	2024	2025		
Q1	3	7	4	7	17	6	44	86,3
Q2			1	2	2		5	9.8
Unranked				1		1	2	3,9
Grand Total		7	5	10	19	7	51	100

b. Data collection methods

The variation of data collection methods that are used in the selected journals can be seen in Figure 3. Most studies implemented a survey to gather research data, with 76% of the total articles. Other studies preferred interview (12%), review (8%), observation (2%) and case study (2%).

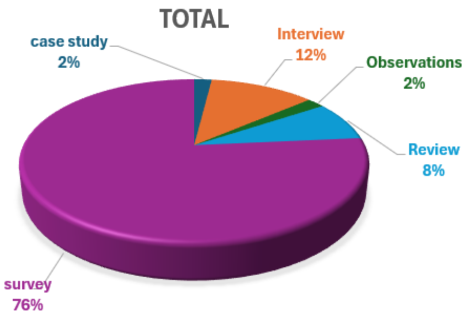

Figure 3. Data collection methods chart (Source: Author's own work)

c. Regional distribution

In Table 3 below, the previous studies that were conducted in many countries and continents develop a global perspective in this research. Most studies from Asia (21 articles) represent the Asian perspective. 33 per cent of them depict the factors that influence European farmers to adopt digital agriculture. Also, two countries from Oceania (Australia and New

Zealand) enrich the perspective of this research.

Table 3. Region setting (Source: Author's own work)

Countries	Continents						Total
	Africa	America	Asia	Europe	Global	Oceania	
Australia						1	1
Bangladesh			1				1
Brazil		2					2
China			9				9
Germany				9			9
Ghana	1						1
Global					3		3
Gulf Cooperation Council (GCC) states			1				1
Hungary				1			1
India			1				1
Indonesia			2				2
Iran			1				1
Italy				5			5
Kingdom of Bahrain			1				1
New Zealand						1	1
Nigeria	1						1
Pakistan			1				1
Republic of Ireland				1			1
Rwanda	1						1
Saudi Arabia			1				1
Switzerland				1			1
Taiwan, China			1				1
Tanzania	1						1
Thailand			1				1
USA		1					1
USA and Brazil		1					1
Vietnam			1				1
Grand Total	4	4	21	17	3	2	51

d. Type of farms

This study has identified that the selected articles focus not only on one type of farm but also on all types of farms (crop and livestock). Although most research focuses on crop farms. However, 13 % of the researchers conducted a study to observe livestock farms, and a quarter of the total research decided to focus on both types of farms, as shown in Figure 4.

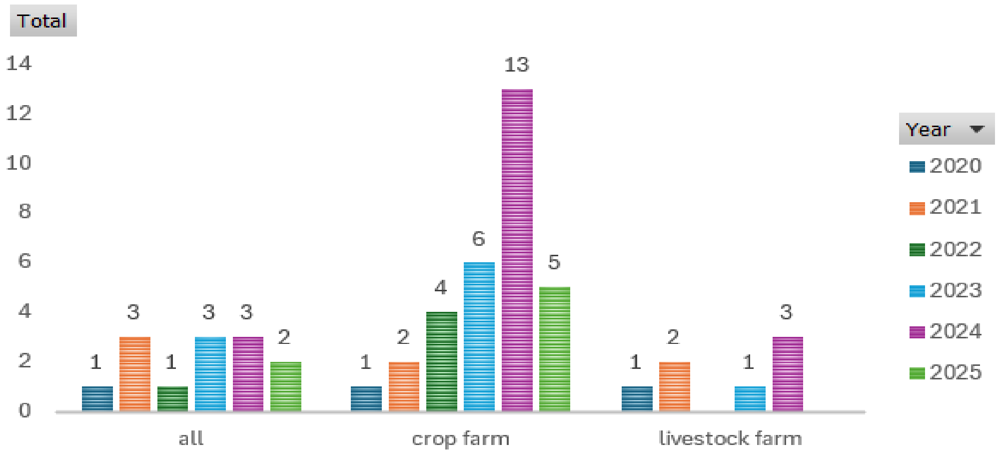

Figure 4. Type of farms chart (Source: Author's own work)

e. Journal distribution

Most selected journals that are related to the determinants factors that influence farmers to adopt digital agriculture are published in the Journal of Sustainability (13,73%). In the second rank, there is the Journal of Agriculture that is ranked Q1 with 11,76 percent. Both journals are published by MDPI. The details of article distribution based on journal title can be seen in Table 4.

Table 4. Journal title (Source: Author's own work)

Journals	Rating	Total	%
Advanced Engineering Informatics, Elsevier	Q1	1	1,96
Aestimum	Q2	1	1,96
Agricultural systems, Elsevier	Q1	2	3,92
Agriculture, MDPI	Q1	6	11,76
Applied sciences, MDPI	Q2	1	1,96
Arab Gulf Journal of Scientific Research, Emerald	Q2	1	1,96
British food journal, emerald	Q1	1	1,96
City and environment interactions, elsevier	Q1	1	1,96
Computers and Electronics in Agriculture, Elsevier	Q1	1	1,96
Environment, Development and Sustainability, Springer	Q1	1	1,96
European Countryside	Q2	1	1,96
Heliyon, Elsevier	Q1	2	3,92
Humanities and Social Sciences Communications	Q1	1	1,96
International trade, politics and development, emerald	Unranked	1	1,96
Journal of Economics, Finance and Accounting Studies	Unranked	1	1,96
Journal of Environmental Management, Elsevier	Q1	1	1,96
Journal of Rural Studies, Elsevier	Q1	3	5,88
Journal of Strategy and Management, Emerald Publishing	Q2	1	1,96
Nature Research	Q1	1	1,96
Plos One	Q1	1	1,96
Precision Agriculture, Springer	Q1	3	5,88
Scientific reports	Q1	1	1,96
Scientific research, nature	Q1	1	1,96

Smart Agricultural Technology, Elsevier	Q1	4	7,84
Social Sciences and Humanities Open, Elsevier	Q1	1	1,96
Sustainability, MDPI	Q1	7	13,73
Technological Forecasting & Social Change, Elsevier	Q1	2	3,92
Technology in society, elsevier	Q1	2	3,92
World Development Perspectives, Elsevier	Q1	1	1,96
Total		51	100

Frequency of Determinants Influencing Digital Agriculture Adoption

To identify the most frequently reported determinants influencing digital agriculture adoption, the factors extracted from the reviewed articles were quantified based on their frequency of appearance in 51 selected articles. The findings of this research are presented in the following review.

Table 5. Findings of the studies (Source: Author's own work)

Studies	Determinat Factors	Articles (n-51)	Percentage (%)
(Al-Ammary & Ghanem, 2023)[29], (Abioye et al., 2024)[30], (Alsanhani et al., 2025)[31], (Santoso et al., 2024)[32], (Selvaggi et al., 2024)[33], (Zeddies et al., 2024)[34], (Geng et al., 2024)[35], (Gao et al., 2024)[36], (Czibere et al., 2023)[37], (Kabirigi et al., 2023)[38], (Georgopoulos et al., 2023)[39], (Cui & Wang, 2023)[40], (Khan et al., 2022)[41], (Giua et al., 2021)[42], (Heise, 2021b)[43], (Silveira et al., 2023), (Tran et al., 2025), (L. Li et al., 2025), (Miine et al., 2023), (Ahmad et al., 2024), (Amoussouhoui et al., 2024), (Spykman et al., 2021), (Gyawali et al., 2023), (Marescotti et al., 2021), (Reissig & Siegrist, 2025), (Giua et al., 2022)	Socioeconomic	26	51
(Santoso et al., 2024), (Kabirigi et al., 2023), (Georgopoulos et al., 2023), (Cui & Wang, 2023), (Khan et al., 2022), (Giua et al., 2021), (Heise, 2021b), (Silveira et al., 2023), (Tran et al., 2025), (L. Li et al., 2025), (Miine et al., 2023), (Amoussouhoui et al., 2024), (Gyawali et al., 2023), (Marescotti et al., 2021), (Reissig & Siegrist, 2025)	Sociodemographic	15	29,4
(Al-Ammary & Ghanem, 2023), (Keefe et al., 2025), (Mallick et al., 2025a), (Santoso et al., 2024), (Knitsch et al., 2024), (Selvaggi et al., 2024), (Zeddies et al., 2024), (L. Li et al., 2024), (Geng et al., 2024), (Gao et al., 2024), (Mushi et al., 2024), (Kabirigi et al., 2023), (Georgopoulos et al., 2023), (Cui & Wang, 2023), (Lin et al., 2023), (Munz & Schuele, 2022), (Khan et al., 2022), (Giua et al., 2021), (Sun et al., 2021), (Heise, 2021b), (Heise, 2021a), (Silveira et al., 2023), (Tran et al., 2025), (L. Li et al., 2025), (Langer et al., 2024), (Miine et al., 2023), (Ahmad et al., 2024), (Amoussouhoui et al., 2024), (Newton et al., 2020), (Cimino et al., 2024), (Gyawali et al., 2023), (Uehleke et al., 2024), (Marescotti et al., 2021), (Reissig & Siegrist, 2025), (Caffaro et al., 2020)	Digital Literacy	35	68,6
(Al-Ammary & Ghanem, 2023), (Abioye et al., 2024), (Keefe et al., 2025), (Alsanhani et al., 2025), (Zhang et al., 2024), (Santoso et al., 2024), (Selvaggi et al., 2024), (L. Li et al., 2024), (Geng et al., 2024), (Gao et	Digital Infrastructure	31	60,7

al., 2024), (Mushi et al., 2024), (Kabirigi et al., 2023), (Shih & Chiu, 2023), (Georgopoulos et al., 2023), (Cui & Wang, 2023), (Taheri et al., 2022), (Khan et al., 2022), (Giua et al., 2021), (Heise, 2021b), (Heise, 2021a), (Marius et al., 2020), (L. Li et al., 2025), (Langer et al., 2024), (Ahmad et al., 2024), (Newton et al., 2020), (Spykman et al., 2021), (Y.-J. Wang et al., 2024), (Cimino et al., 2024), (Gyawali et al., 2023), (Ramadan et al., 2025), (Caffaro et al., 2020)			
(Al-Ammary & Ghanem, 2023), (Keefe et al., 2025), (Mallick et al., 2025b), (L. Li et al., 2024), (Mushi et al., 2024), (Czibere et al., 2023), (Georgopoulos et al., 2023), (Cui & Wang, 2023), (Munz & Schuele, 2022), (Giua et al., 2021), (Sun et al., 2021), (Heise, 2021b), (Heise, 2021a), (Marius et al., 2020), (Kenny & Regan, 2021), (L. Li et al., 2025), (Langer et al., 2024), (Ahmad et al., 2024), (Newton et al., 2020), (Y.-J. Wang et al., 2024), (Marmont et al., 2024), (Cimino et al., 2024), (Ramadan et al., 2025)	Ease of Use	23	45
(Al-Ammary & Ghanem, 2023), (Keefe et al., 2025), (L. Li et al., 2024), (Geng et al., 2024), (Georgopoulos et al., 2023), (Cui & Wang, 2023), (Munz & Schuele, 2022), (Silveira et al., 2023), (L. Li et al., 2025), (Miine et al., 2023), (Ahmad et al., 2024), (Newton et al., 2020), (Uehleke et al., 2024)	Financial Support	14	27,4
(Alsanhani et al., 2025), (Mallick et al., 2025b), (Zhang et al., 2024), (Colussi et al., 2024), (Zeddies et al., 2024), (Czibere et al., 2023), (Shih & Chiu, 2023), (Georgopoulos et al., 2023), (Cui & Wang, 2023), (Munz & Schuele, 2022), (Giua et al., 2021), (Sun et al., 2021), (Heise, 2021a), (Marius et al., 2020), (Silveira et al., 2023), (Tran et al., 2025), (L. Li et al., 2025), (Newton et al., 2020), (Spykman et al., 2021), (Y.-J. Wang et al., 2024), (Cimino et al., 2024), (Gyawali et al., 2023), (Ramadan et al., 2025), (Reissig & Siegrist, 2025), (Piancharoenwong & Badir, 2024), (Giua et al., 2022)	Benefit Expectation	26	50,9
(Al-Ammary & Ghanem, 2023), (Abioye et al., 2024), (Keefe et al., 2025), (Alsanhani et al., 2025), (Santoso et al., 2024), (Knitsch et al., 2024), (Colussi et al., 2024), (L. Li et al., 2024), (Geng et al., 2024), (Gao et al., 2024), (Shih & Chiu, 2023), (Georgopoulos et al., 2023), (Cui & Wang, 2023), (Lin et al., 2023), (Taheri et al., 2022), (Sun et al., 2021), (Silveira et al., 2023), (Kenny & Regan, 2021), (Tran et al., 2025), (L. Li et al., 2025), (Miine et al., 2023), (Ahmad et al., 2024), (Newton et al., 2020), (Marmont et al., 2024), (Gyawali et al., 2023), (Ramadan et al., 2025), (Uehleke et al., 2024), (Reissig & Siegrist, 2025), (Piancharoenwong & Badir, 2024), (Caffaro et al., 2020)	Government Intervention	30	58,8
(Keefe et al., 2025), (Mallick et al., 2025b), (Colussi et al., 2024), (Zeddies et al., 2024), (Mushi et al., 2024), (Czibere et al., 2023), (Georgopoulos et al., 2023), (Lin et al., 2023), (Taheri et al., 2022), (Colussi et al., 2022), (Sun et al., 2021), (Heise, 2021b), (Heise, 2021a), (Miine et al., 2023), (Amoussouhoui et al., 2024), (Newton et al., 2020), (Marmont et al., 2024), (Cimino et al., 2024), (Ramadan et al., 2025), (Uehleke et al., 2024), (Marescotti et al., 2021), (Giua et al., 2022)	Social Influences	20	39,2

(Abioye et al., 2024), (Zhang et al., 2024), (Santoso et al., 2024), (Selvaggi et al., 2024), (Zeddies et al., 2024), (Kabirigi et al., 2023), (Georgopoulos et al., 2023), (Cui & Wang, 2023), (Taheri et al., 2022), (Munz & Schuele, 2022), (Giua et al., 2021), (Silveira et al., 2023), (Tran et al., 2025), (Langer et al., 2024), (Ahmad et al., 2024), (Spykman et al., 2021), (Y.-J. Wang et al., 2024), (Marmont et al., 2024), (Gyawali et al., 2023), (Ramadan et al., 2025), (Marescotti et al., 2021)	Investment Cost	21	41,2
(Knitsch et al., 2024), (L. Li et al., 2024), (Gao et al., 2024), (Georgopoulos et al., 2023), (Heise, 2021b), (Newton et al., 2020), (Langer et al., 2024)	Personal Experience	7	13,8

According to Table 5, digital literacy is the most frequently reported factor at 68,6%, followed by digital infrastructure (60,7%), government intervention (58,8%), socioeconomic factors (51%), and benefit expectation (50,9%). The high frequency of these factors suggests that digital agriculture adoption results from a combination of technological readiness, institutional support, and farmers' economic conditions. In the specific aspect, technological capabilities such as digital literacy and digital infrastructure are essential. Before evaluating the potential benefits of digital technologies, farmers should have the necessary skills and be able to access the technologies. In addition, the prominence of socioeconomic conditions and government intervention indicates that the adoption process is also influenced by policy and resource availability. These findings highlight that the adoption of digital agriculture is a multidimensional process. Technological, organisational, and environmental aspects have influenced digital agriculture adoption.

The frequency analysis also indicates that the identified factors in this study are not independent but rather interact with each other. For instance, socioeconomic capacity influences the capability to access digital infrastructure and invest in digital technologies. Also, government intervention with the training program can improve digital literacy. It can be assumed that the factors are not single determinants. They are interconnected and interact with multiple factors at different levels. Therefore, this study synthesises using the TOE framework to provide a structured understanding of how the factors can influence the farmers’ decision to adopt digital agriculture technologies.

Conceptual Framework of Digital Agriculture Adoption

Based on the synthesis of the reviewed literature, a conceptual framework is proposed to illustrate the key determinants influencing digital agriculture adoption. The framework is structured using the TOE framework. The TOE framework integrates the factors into the technological characteristics, organisational readiness, and environmental conditions as shown in Figure 5.

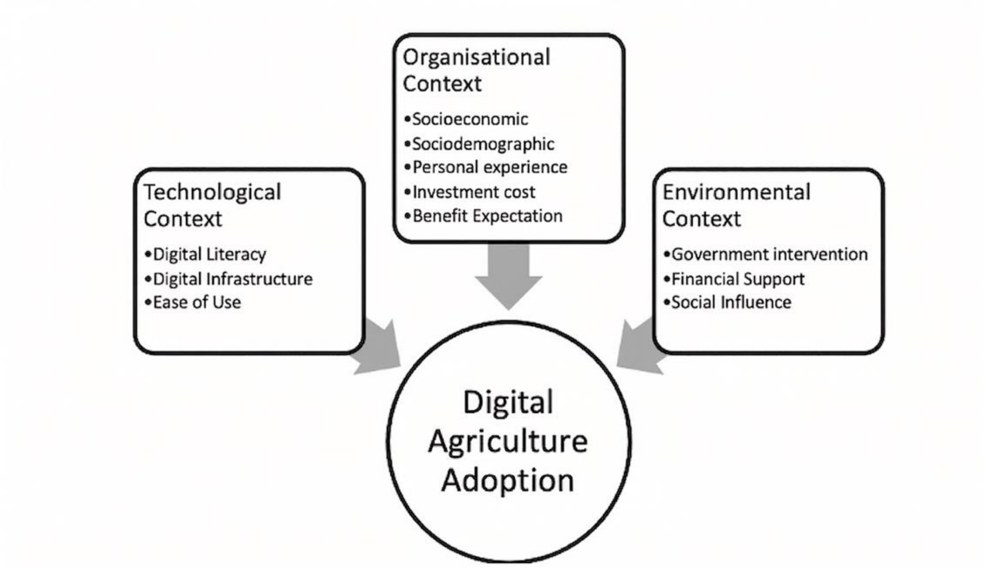

Figure 5. Conceptual framework of determinants influencing digital agriculture adoption based on the TOE framework (Source: Author's own work)

The following sections discuss in detail how the factors were grouped into each context and contribute to the digital agriculture adoption.

a. Technological Context

In the TOE framework, the technological context refers to the characteristics and usability of digital technologies that encourage farmers to adopt the technology. Four factors can be included in this context, which are:

- Digital Literacy

Digital literacy is the ability to know, to use, and to manage digital technology. In the agricultural sector, digital literacy is an essential aspect to promote technology adoption(Aranguri et al., 2025). Digital literacy drives farmers to be more open to the advancement of technology and the changes in agriculture(Gong et al., 2024). Having this kind of literacy, farmers can find information on digital platforms, identify the information, use the information and share the information with their communities. Hence, the improvement of digital literacy among farmers in this digital age is not only to improve the adoption of digital technology probability but also to protect them from digital crime(Mols, 2021).

Based on the literature review, more than 68 per cent of the total articles reviewed mentioned digital literacy as the key to digital agriculture adoption. In research conducted in Asia continent, 10 articles from 14 articles believe that digital literature is a matter. This aspect is also mentioned in similar studies from Europe (12 articles), America (2 articles), Africa (3 articles), Oceania (1 article) and global (3 articles). It can be assumed that from a global perspective, basic digital knowledge is believed to be an accelerator that can encourage farmers to learn more about new digital technologies in agriculture. The basic digital skills, such as knowledge about computers, social media, smartphones, the internet, and data, have a positive impact on farmers' behaviours (Bai et al., 2023).

- Digital Infrastructure

The accessibility to digital infrastructure has been identified as the matter component in digital agriculture. The adequate infrastructures, such as internet access (Gyawali et al., 2023), electricity(Gao et al., 2024), appropriate digital devices(Alsanhani et al., 2025), and ICT services apps(Kabirigi et al., 2023) are part of digital readiness.

Together with digital literacy, digital infrastructure is a foundation of digital agriculture. Before promoting the use of digital technology in farms, both factors should be measured in the appropriate readiness level(J. Chen et al., 2024). Also, the establishment of digital infrastructure is effective in motivating farmers to use digital tools(Y. Liu et al., 2025). Without digital infrastructure readiness, the high willingness to adopt digital technology in agriculture by farmers is hard to actualise. First, it increases the investment costs. Farmers who want to adopt the technology should provide more funds to prepare the infrastructure. Second, farmers find it difficult to train in the use of advanced technology on their farms without the sophisticated infrastructure.

Digital infrastructure development, especially in rural areas, is also essential to decrease digital gaps that can result in barriers to the effort of digital transformation in the agricultural sector(Gwaka et al., 2020). The present digital infrastructure, such as internet access, provides more resources for farmers in rural areas to obtain information(Khanal et al., 2021). It will change farmers' behaviour to find solutions for solving their problems on the farms. It also increases the possibility of the digital agriculture adoption rate.

- Ease of Use

In the selected articles, ease of use has been mentioned in 23 of 51 articles. Almost 50% from the articles mentioned this term focused on experiences in developed countries (5 articles from Germany and 5 articles from China) that are more advanced in digital technology implementation for agriculture. So, learning from them is a useful strategy to enhance the adoption of digital agriculture. Consequently, some points should be highlighted in digital technology development, such as considering age group(Al-Ammary & Ghanem, 2023), user-friendly oriented(Keefe et al., 2025), uncomplicated system(L. Li et al., 2024), Manageable(Czibere et al., 2023), customizable(Giua et al., 2021), learnable(Ramadan et al., 2025), and accessible(Ahmad et al., 2024).

To provide ease-of-use technology, the age of users should be considered. It is essential to attract users' attention. For instance, older users need more icons and larger fonts than younger users. So, having multiple perspectives across all age groups is essential to improve utilisation (Al-Ammary & Ghanem, 2023). Besides that, the digital technology for agriculture should be user-oriented. When technology is user-friendly, the users will be more attracted to learn and to practice(Georgopoulos et al., 2023). Farmers are also concerned about difficulty and complexity. The more complex the system, the more difficult farmers to obtain the best performance(L. Li et al., 2024). So, digital technology tools should be simple, and farmers can manage the technology easily.

b. Organisational Context

Within the TOE framework, the organisational factors describe internal characteristics of farmers and resources that influence the process of adoption decision. These factors can be assumed to contribute to shaping farmers' capacity and readiness to adopt digital agriculture technologies. Factors that can be grouped in this context are:

- Socioeconomics

Socioeconomics or social class refers to the level of people in society that is commonly measured by income, educational background, wealth, or prestige(Antonoplis, 2023). Socioeconomic is essential to be considered to influence people's psychology(Vadivel et al., 2023). It means that this factor plays an important role in decision-making processes. In Table 5, the presence of this term in the selected articles is more than 50% of the total articles. It can be assumed that socioeconomics are valuable factors that can make farmers interested in digital technologies adoption in agriculture. There are three aspects that are regularly mentioned in socioeconomic groups from this study, which are educational background, income and farm scale.

First, the level of education is a foundation for human capabilities(Rivaldo & Nabella, 2023). Education changes the way of thinking, the kind of social group and problem-solving ability. Farmers with proper educational backgrounds are more likely to use the technology for their farms. Second, there is a high correlation between income and the level of people's self-esteem(Bleidorn et al., 2023). So, it can be assumed that farmers with high incomes are more confident to take more risks or learn new things. Third, farm-scale matters in terms of factors that can influence farmers to adopt digital agriculture. It is caused by the Farmland scale that relates to the accessibility of financial capital(Y. Chen et al., 2022). Consequently, farmers with large farmland have more options to access funding resources than others. In addition, farmers with large farm size, needs technology to manage the complexity and to improve efficiency in farm production(Giua et al., 2021).

- Sociodemographic

The definition of sociodemographic depends on two words, which are social and demography(Vo et al., 2023). It means that, in society, people can be clustered according to some characteristics such as age, gender, nationality, religion, ethnicity, and marital status(Nafilyan et al., 2021). In this research, there are two sociodemographic aspects that are found, which are gender and age.

The accessibility of young farmers to update information and technology tools makes them familiar with the new technology(Kabirigi et al., 2023). Young people also have a strong willingness to learn. On the other hand, elderly farmers are more likely to prevent the risks and changes(Santoso et al., 2024). Old farmers focus on short-term outcomes. The probability of computer usage by farmers decreases with age(Heise, 2021b). It can be concluded that the effort to influence old farmers is more complex than that of young farmers in terms of the adoption of digital agriculture.

The different role between males and females in the farms generates a disparity(Amoussouhoui et al., 2024). On the farm, female farmers are commonly responsible as assistants. So, they are limited to being involved in the farm businesses. The different ways to access information, because of the different opportunities to access technology, provide different ways to make decision-making processes among male and female farmers. Thus, male farmers are more confident to decide the technology adoption than female farmers(Kamalu & Kamalu, 2025).

- Benefits Expectation

To implement the use of digital technology for agriculture, farmers have their own expectations about the advantages that will be gained. More than half of the total selected studies that are reviewed in this research talked about benefit expectations as influence factors for digital agriculture adoption. It commonly happens when there is a new thing that will be utilised, the big question followed is about the benefits. However, the beneficial expectations that are identified from the previous research are not only about financial benefits but also about non-financial benefits. Based on literature review analysis, performance improvement(Zhang et al., 2024), efficient work process(Silveira et al., 2023), information accessibility(Alsanhani et al., 2025), labour issue solutions(Zeddies et al., 2024), confidence and credibility improvement(Mallick et al., 2025a) and environmental benefits(Spykman et al., 2021) are highlighted as non-financial benefits that are expected by farmers.

According to the identified farmers' expectations, the features of digital tools that will be implemented in the agricultural sector should be examined, considering the mentioned expectations. Most farmers hope the implemented technology can solve their daily problems, reduce costs, and enhance their productivity(Giua et al., 2022). In daily activities, farmers face many problems and challenges that should be solved, such as unpredictable climate, the lack of labour, limited water supply, high production cost, land crisis, pest and disease harms(Abdullah et al., 2013). So, it is essential to measure that farmers' expectations are accommodated with the adopted digital tools.

- Investment cost

The investment cost is the most essential aspect that determines the actual adoption of digital agriculture by farmers(Abioye et al., 2024). Spending funds to invest in new technology adoption is not a simple decision for farmers. Investment cost to adopt digital technology in agriculture consists of the price to purchase the tools, infrastructure preparation, transfer knowledge cost, and maintenance cost. Before calculating the benefits of technology adoption, people tend to consider the price of technology. The investment cost should provide sophisticated benefits for farmers(Y.-J. Wang et al., 2024). Farmers also count the investment cost and the value of technology(Zhang et al., 2024). The affordable price of technology and the purchasing ability of farmers are highlighted by almost half of the selected articles in this research.

To accommodate this factor and to increase the adoption rate of digital technology by farmers, there are some strategies that can be implemented. First, the value of technology should be profitable for farmers(Kugbega & Aboagye, 2021). The benefits that are achieved from investment are more valuable than the amount of funds that is spent. Thus, the period to achieve return on investment is not a long time. Second, providing more options of prices to farmers with clustering technology based on the level of material quality or the functionality(Coles et al., n.d.). Hence, farmers can decide to purchase the tools depending on their economic capacity. Third, divide digital technology into some packages to prevent the investment cost for the whole set of digital technology. For instance, Internet of Things (IoT) adoption can be divided into some packages, such as IoT for monitoring soil condition, IoT for watering, IoT for checking plant health, and IoT for checking weather conditions. Fourth, providing subsidies or credit is also effective in reducing the initial cost for farmers. With this financial support, farmers can manage their investment based on their necessary requirements and capabilities (Jabbari et al., 2023). Fifth, encourage farmers to divide the investment cost with other farmers by sharing digital technology in their group. With this scheme, the individual cost for investment can be significantly reduced(Hu et al., 2025).

- Personal Experiences

Personal experiences as a factor that can influence farmers to adopt digital agriculture have been mentioned in 7 previous studies from 51 articles that are analysed in this research. It affirms that experience is essential for new technology adoption(Knitsch et al., 2024). With personal experience, farmers have a vivid description of digital agriculture technology. Thus, they can consider the benefits of technology adoption for their farms. The kinds of personal experience that are highlighted include practical experience(Georgopoulos et al., 2023), familiarity with advanced technology(Langer et al., 2024), understanding the value of technology(L. Li et al., 2024) and working experience(Heise, 2021b).

Practising the new technology can improve the farmers' knowledge about the usefulness of the technology and help them understand how it will be used(Georgopoulos et al., 2023). Some farmers could understand the advanced technology from their working experience. It can help them to decide about the adoption of technology. However, this opportunity is not experienced by all farmers. Training and dissemination of technology should be conducted to encourage farmers' awareness about digital agriculture technology. With training programs, farmers have opportunities to try the technology and understand how to use it for their farms. It means that farmers can practice the actual use of technology and have a chance to be familiar with the tools. It is effective to improve farmers' personal experience and knowledge. This experience helps farmers to understand the potency of the technology for their success(Langer et al., 2024). Hence, the willingness to implement the technology on their farms will also increase.

c. Environmental Context

The environmental context represents the external conditions that impact technology adoption. It can be institutional support, policy, or a social network. Three factors are identified, which are:

- Financial Support

In some countries, financial support is effective in encouraging farmers to use digital technology to manage their farms(Gao et al., 2024). Based on the previous research reviewed in this study, there are 14 of 51 articles that point to financial support as a factor that influences farmers to adopt digital agriculture technology. It can be assumed that financial support should be considered in digital agriculture programs. Farmers need more access to credit(Miine et al., 2023) and financial incentives(Keefe et al., 2025) to enhance production and to adopt advanced technology for their farms. This factor matters because it helps small farms to access technology(Munz & Schuele, 2022).

Financial incentives that are commonly presented by governments, such as subsidies, low interest rates and financial services, increase the possibility of technology adoption by farmers(Cui & Wang, 2023). In an organisation, the implementation of incentives is effective to improve performance and motivation(W. Liu & Liu, 2022). Hence, the promotion of the adoption of digital agriculture that offers special privileges to farmers to access financial incentives could improve the farmers' willingness to adopt digital agriculture technology. Subsidies and low interest rates can help farmers to decrease the investment cost for technology adoption.

Initial investment and operating costs are barriers for farmers to adopt advanced technology for their farms. The cost to adopt digital technologies for agriculture is relatively expensive for farmers(Munz & Schuele, 2022). The calculation of benefits and costs before adopting digital agriculture includes the availability of investment funds. The opportunity to access loans for covering investment costs is valuable to help farmers who want to adopt digital technologies. Loans or credit will help farmers to prevent direct costs for this adoption.

- Government Intervention

The government's role is crucial to accelerate digital agriculture adoption. Support from governments can encourage farmers to get involved in digital agriculture adoption(Al-Ammary & Ghanem, 2023). In addition, government support can help to improve the recognition of technology among farmers(L. Li et al., 2024). According to selected papers, interventions from the government have been confirmed by 58% of reviewed articles as determinant factors for digital technology implementation in agriculture. Some interventions have been marked, such as workshops and training programs (Al-Ammary & Ghanem, 2023), promotion(Keefe et al., 2025), extension services(Alsanhani et al., 2025), regulation(Marmont et al., 2024), policy(Shih & Chiu, 2023), consultation services(Tran et al., 2025), and dissemination(Colussi et al., 2024). Hence, based on the experience of some countries, the presence of governments through some interventions is needed by farmers as a guarantee that digital transformation in agriculture can run smoothly and be useful.

To provide the appropriate interventions, first, the government should hear and analyse the conditions and the aspirations of people in their territories(Wibowo, 2024). In this context, the problems and challenges that are experienced by farmers are different in each country, depending on many factors such as economics, climate, and natural resources. For instance, in some rural areas, the digital literacy rate among farmers is low. It is caused by the lack of access to information and digital infrastructure. The appropriate intervention for them is to improve their digital knowledge and digital skills through some training or an information section. With the training or information section, their knowledge about digital technology usage for agriculture is updated(Miine et al., 2023). Consequently, it is followed by an increase in the intensity of uptake of digital agriculture among farmers(L. Li et al., 2024).

- Social Influences

Social influence impacts on people's behaviour of perceived usefulness and triggers the actual usage(Haverila et al., 2023). Farmers tend to share their knowledge and experiences with their social network(Albizua et al., 2021). Individual decisions among members of society are not independent, but are influenced by other members(Ren et al., 2022). So, social influence should be counted as a determinant factor of digital agriculture adoption by farmers. 20 articles from 51 selected articles mention this term. According to the articles, farmers' decision to use digital agriculture technology has been influenced by success stories from other members in communities(Keefe et al., 2025), social media(Colussi et al., 2024), motivation from communities(Mushi et al., 2024), peer influence(Georgopoulos et al., 2023), communities' assumption(Uehleke et al., 2024), advertisement(Amoussouhoui et al., 2024) and communities' experience(Marescotti et al., 2021).

In the digital era, the scope of society is beyond geographical aspects(Levin & Mamlok, 2021). For modern farmers, social networks are not limited to people in the region but can also connect with other people on other continents. Farmers from Asian countries are likely to be members of a network society with other farmers from European countries. The source of information is also more varied, such as content from social media and other digital platforms. Social media is effective in connecting people, sharing knowledge, communication, collaboration, and learning media(Martoredjo, 2023). For instance, the experience of farmers in China who are successful in increasing farm productivity with the adoption of digital tools can inspire other farmers from other countries. It happens when success stories have been posted on social media or other digital platforms, so other members of society around the world can access success stories and learn from them.

However, not all farmers have enough digital skills and digital resources to connect with social media. Traditional farmers in rural areas that are isolated from digital infrastructure are still using traditional ways to connect with other people. The media and time availability that are owned by traditional farmers to share knowledge and stories with other members in society are different from using social media(Masambuka-Kanchewa et al., 2021). Traditional farmers use direct interaction and communication with other members in society. They share their knowledge and experiences with their society through practical experiences and collaboration on the farms. Hence, the role of co-farmers, relatives or people around farmers is essential to influence their behaviours to adopt(Diaz et al., 2021).

Regional patterns are also highlighted in the reviewed literature. Most studies from Asian countries result in digital literacy and digital infrastructure as dominant determinants in digital agricultural technologies adoption. In contrast, in African countries, financial support and infrastructure limitation as major barriers. Meanwhile, research conducted in Europe focuses on technological usability, system integration, and environmental benefits of digital agriculture. These regional differences indicate that the determinants of digital agriculture adoption depend on socioeconomic conditions, technological maturity and institutional support across regions.

Overall, the findings indicate that digital agriculture adoption is influenced by the interaction of technological readiness, farmers' internal capacity, and external aspects. While the technological aspect enables the practical use of digital agricultural technologies, the organisational aspect determines the farmers' ability to implement the digital technologies in agriculture. Meanwhile, environmental aspects, including policies and social influence, are essential to generate a supportive ecosystem that can accelerate the adoption process of digital agricultural technologies.

CONCLUSIONS AND SUGGESTION

Digital agriculture is essential for addressing intersectional problems between agricultural productivity and environmental sustainability. To enhance the adoption of digital agriculture among farmers, understanding the factors that influence farmers' decisions to adopt digital technologies is crucial. Based on this systematic literature review, the determinants influencing digital agriculture adoption can be categorised into three context within the Technology-Organisation-Environment framework. Technological factors indicate the capabilities and characteristics of digital technologies, organisational factors depict the farmers' internal characteristics and resources, and environmental factors refer to external influences such as government support and social networks. This study contributes by synthesising global evidence and proposing a structured TOE-based categorisation of determinant factors of digital agricultural technology adoption among farmers. The findings of this study provide useful insights for future research and offer important implications for policymakers and stakeholders in developing strategies and policies to enhance the adoption of digital agriculture technologies among farmers.

REFERENCES

Abdullah, M., Cuixia, L., Ghazanfar, S., Rehman, A., Ghazanfar, B., & Saud, S. (2013). Problems faced by rice growing farmers and their behavior to the government policies: A case from Pakistan. *Journal of Biology, Agriculture and Healthcare*, *3*(16), 1–9.

Abioye, D. O., Popoola, O., Akande, A., Fadare, D. A., Omitoyin, S. A., Yinusa, B., & Kolade, O. O. (2024). Farmersâ€™ willingness to adopt digital application tools in Ogun State, Nigeria. *Journal of Strategy and Management Journal of Strategy and Management*, *Query date: 2025-09-09 23:07:10*. https://doi.org/10.1108/JSMA-06-2023-0135.

Ahmad, B., Sarkar, M. A. R., Khanom, F., Lucky, R. Y., Sarker, M. R., Rabbani, M. G., Ray, S. R. R., Rahman, M. N., & Sarker, M. N. I. (2024). Experience of farmers using mobile phone for farming information flow in Boro rice production: A case of Eastern Gangetic Plain. *Social Sciences & Humanities Open*, *9*(Query date: 2025-09-09 22:06:53), 100811. https://doi.org/10.1016/j.ssaho.2024.100811.

Al-Ammary, J. H., & Ghanem, M. E. (2023). Information and communication technology in agriculture: Awareness, readiness and adoption in the Kingdom of Bahrain. *Arab Gulf Journal of Scientific Research Arab Gulf Journal of Scientific Research*, *1*, 182–197. https://doi.org/10.1108/AGJSR-07-2022-0113.

Albizua, A., Bennett, E. M., Larocque, G., Krause, R. W., & Pascual, U. (2021). Social networks influence farming practices and agrarian sustainability. *PloS One*, *16*(1), e0244619.

Alsanhani, A. N., Al-Shayaa, M. S., Dabiah, A. T., & Alfridi, J. S. (2025). Advancing Sustainable Agriculture Through Digital Technology: The Role of the â€˜Agricultural Guideâ€™ App in Improving Olive Farming Practices in Saudi Arabia. *Sustainability*, *17*(6), 2340. https://doi.org/10.3390/su17062340.

Amoussouhoui, R., Arouna, A., Ruzzante, S., & Banout, J. (2024). Adoption of ICT4D and its determinants: A systematic review and meta-analysis. *Heliyon*, *10*(9). https://doi.org/10.1016/j.heliyon.2024.e30210.

Antonoplis, S. (2023). Studying socioeconomic status: Conceptual problems and an alternative path forward. *Perspectives on Psychological Science*, *18*(2), 275–292.

Aranguri, M., Mera, H., Noblecilla, W., & Lucini, C. (2025). Digital Literacy and Technology Adoption in Agriculture: A Systematic Review of Factors and Strategies. *AgriEngineering*, *7*(9), 296.

Babineau, J. (2014). Product review: Covidence (systematic review software). *Journal of the Canadian Health Libraries Association/Journal de l'Association Des Bibliothèques de La Santé Du Canada*, *35*(2), 68–71.

Bai, Q., Chen, H., Zhou, J., Li, G., Zang, D., Sow, Y., & Shen, Q. (2023). Digital literacy and farmers' entrepreneurial behavior—Empirical analysis based on CHFS2019 micro data. *Plos One*, *18*(7), e0288245.

Basenach, L., Renneberg, B., Salbach, H., Dreier, M., & Woelfling, K. (2023). Systematic reviews and meta-analyses of treatment interventions for Internet use disorders: Critical analysis of the methodical quality according to the PRISMA guidelines. *Journal of Behavioral Addictions*, *12*(1), 9–25.

Bellon-Maurel, V., Piot-Lepetit, I., Lachia, N., & Tisseyre, B. (2023). Digital agriculture in Europe and in France: Which organisations can boost adoption levels? *Crop and Pasture Science*, *74*(6), 573–585.

Bibi, F., & Rahman, A. (2023). An overview of climate change impacts on agriculture and their mitigation strategies. *Agriculture*, *13*(8), 1508.

Bleidorn, W., Kretzschmar, A., Rauthmann, J. F., Orth, U., Denissen, J. J., & Hopwood, C. J. (2023). Self-esteem and income over time. *Psychological Science*, *34*(10), 1163–1172.

Caffaro, F., Cremasco, M. M., Roccato, M., & Cavallo, E. (2020). Drivers of farmersâ€™ intention to adopt technological innovations in Italy: The role of information sources, perceived usefulness, and perceived ease of use. *Journal of Rural Studies*, *76*(Query date: 2025-09-09 22:06:53), 264–271. https://doi.org/10.1016/j.jrurstud.2020.04.028

Chen, J., Hou, H., Liao, Z., & Wang, L. (2024). Digital environment, digital literacy, and farmers' entrepreneurial behavior: A discussion on bridging the digital divide. *Sustainability*, *16*(23), 10220.

Chen, Y., Fu, X., & Liu, Y. (2022). Effect of farmland scale on farmers' application behavior with organic fertilizer. *International Journal of Environmental Research and Public Health*, *19*(9), 4967.

Cimino, A., Coniglio, I. M., Corvello, V., Longo, F., Sagawa, J. K., & Solina, V. (2024). Exploring small farmers behavioral intention to adopt digital platforms for sustainable and successful agricultural ecosystems. *Technological Forecasting and Social Change*, *204*(Query date: 2025-09-09 22:06:53), 123436. https://doi.org/10.1016/j.techfore.2024.123436

Coles, D. X., George, J., & Miller, M. (n.d.). *Three-Tier Pricing Model: Differentiation Based On Consumer Psychology, Market Positioning, and Added-Value Incentives*.

Colussi, J., Morgan, E. L., Schnitkey, G. D., & Padula, A. D. (2022). How Communication Affects the Adoption of Digital Technologies in Soybean Production: A Survey in Brazil. *Agriculture*, *12*(5), 611. https://doi.org/10.3390/agriculture12050611

Colussi, J., Sonka, S., Schnitkey, G. D., Morgan, E. L., & Padula, A. D. (2024). A Comparative Study of the Influence of Communication on the Adoption of Digital Agriculture in the United States and Brazil. *Agriculture*, *14*(7), 1027. https://doi.org/10.3390/agriculture14071027.

Coulibaly, T. P., Du, J., & Diakité, D. (2021). Sustainable agricultural practices adoption. *Agriculture*, *67*(4), 166–176.

Cui, L., & Wang, W. (2023). Factors Affecting the Adoption of Digital Technology by Farmers in China: A Systematic Literature Review. *Sustainability*, *15*(20), 14824. https://doi.org/10.3390/su152014824

Czibere, I., KovÃ¡ch, I., & LoncsÃ¡k, N. (2023). Hungarian Farmers and the Adoption of Precision Farming. *European Countryside*, *15*(3), 366–380. https://doi.org/10.2478/euco-2023-0020

Das, A., Kumar, S., Kasala, K., Nedumaran, S., Paithankar, P., Kumar, A., Jain, A., & Avinandan, V. (2025). Effects of climate change on food security and nutrition in India: A systematic review. *Current Research in Environmental Sustainability*, *9*(Query date: 2025-09-09 22:06:43), 100286. https://doi.org/10.1016/j.crsust.2025.100286

Diaz, A. C., Sasaki, N., Tsusaka, T. W., & Szabo, S. (2021). Factors affecting farmers' willingness to adopt a mobile app in the marketing of bamboo products. *Resources, Conservation & Recycling Advances*, *11*, 200056. https://doi.org/10.1016/j.rcradv.2021.200056

Fauzi, M. A. (2023). Consumer purchase of halal certified product: A quantitative systematic literature review. *Journal of Islamic Marketing*, *14*(6), 1397–1416.

Gao, T., Lu, Q., Zhang, Y., & Feng, H. (2024). Does Farmersâ€™ Cognition Enhance Their Enthusiasm for Adopting Sustainable Digital Agricultural Extension Services? Evidence from Rural China. *Sustainability*, *16*(10), 3972. https://doi.org/10.3390/su16103972

Geng, W., Liu, L., Zhao, J., Kang, X., & Wang, W. (2024). Digital Technologies Adoption and Economic Benefits in Agriculture: A Mixed-Methods Approach. *Sustainability*, *16*(11), 4431. https://doi.org/10.3390/su16114431

Georgopoulos, V. P., Gkikas, D. C., & Theodorou, J. A. (2023). Factors Influencing the Adoption of Artificial Intelligence Technologies in Agriculture, Livestock Farming and Aquaculture: A Systematic Literature Review Using PRISMA 2020. *Sustainability*, *15*(23), 16385. https://doi.org/10.3390/su152316385

Giua, C., Materia, V. C., & Camanzi, L. (2021). Management information system adoption at the farm level: Evidence from the literature. *British Food Journal*, *123*(3), 884–909. https://doi.org/10.1108/BFJ-05-2020-0420

Giua, C., Materia, V. C., & Camanzi, L. (2022). Smart farming technologies adoption: Which factors play a role in the digital transition? *Technology in Society*, *68*(Query date: 2025-09-09 22:06:53), 101869. https://doi.org/10.1016/j.techsoc.2022.101869

Gong, S., Sun, Z., Wang, B., & Yu, Z. (2024). Could digital literacy contribute to the improvement of green production efficiency in agriculture? *Sage Open*, *14*(1), 21582440241232789.

Gwaka, L., May, J., & Tucker, W. (2020). *The impacts of digital infrastructure transformation on livestock system sustainability in rural communities*.

Gyawali, B. R., Paudel, K. P., Jean, R., & Banerjee, S. â€œBanâ€. (2023). Adoption of computer-based technology (CBT) in agriculture in Kentucky, USA: Opportunities and barriers. *Technology in Society*, *72*(Query date: 2025-09-09 22:06:53), 102202. https://doi.org/10.1016/j.techsoc.2023.102202

Hammouti, B., Aichouch, I., Kachbou, Y., Azzaoui, K., & Touzani, R. (2025). Bibliometric analysis of global research trends on UMI using Scopus database and VOS viewer from 1987–2024. *J. Mater. Environ. Sci*, *16*(4), 548–561.

Haverila, M. J., McLaughlin, C., & Haverila, K. (2023). The impact of social influence on perceived usefulness and behavioral intentions in the usage of non-pharmaceutical interventions (NPIs). *International Journal of Healthcare Management*, *16*(1), 145–156.

Heise, H. (2021a). German Farmersâ€™ Attitudes on Adopting Autonomous Field Robots: An Empirical Survey. *Agriculture*, *11*(3), 216. https://doi.org/10.3390/agriculture11030216

Heise, H. (2021b). Towards an Understanding of the Behavioral Intentions and Actual Use of Smart Products among German Farmers. *Sustainability*, *13*(12), 6666. https://doi.org/10.3390/su13126666

Hu, H., Dai, O., Qin, L., & Li, J. (2025). An investigation into the cost-sharing mechanism of order agriculture with consideration for green investment. *Cogent Food & Agriculture*, *11*(1), 2485324.

Hunt, E., Femia, F., Werrell, C., Christian, J. I., Otkin, J. A., Basara, J., Anderson, M., White, T., Hain, C., Randall, R., & McGaughey, K. (2021). Agricultural and food security impacts from the 2010 Russia flash drought. *Weather and Climate Extremes*, *34*, 100383. https://doi.org/10.1016/j.wace.2021.100383

Jabbari, A., Humayed, A., Reegu, F. A., Uddin, M., Gulzar, Y., & Majid, M. (2023). Smarfarming revolution: Farmer's perception and adoption of smart iot technologies for crop health monitoring and yield prediction in jizan, Saudi Arabia. *Sustainability*, *15*(19), 14541.

Jiang, Q., Li, J., Si, H., & Su, Y. (2022). The Impact of the Digital Economy on Agricultural Green Development: Evidence from China. *Agriculture*, *12*(8). https://doi.org/10.3390/agriculture12081107

Kabirigi, M., Sekabira, H., Sun, Z., & Hermans, F. (2023). The use of mobile phones and the heterogeneity of banana farmers in Rwanda. *Environment, Development and Sustainability*, *25*(6), 5315–5335. https://doi.org/10.1007/s10668-022-02268-9

Kamalu, N. C., & Kamalu, H. O. (2025). The Role of Gender in Technology Adoption and Diffusion in the United States. *European Journal of Science, Innovation and Technology*, *5*(2), 53–68.

Keefe, D. H. S., Jang, H., & Ercan, E. N. (2025). Digitalization in sustainable agriculture supply chain: How digital literacy and support affect attitudes and adoption intentions. *International Trade, Politics and Development International Trade, Politics and Development*, *Query date: 2025-09-09 23:07:10*, 1–16. https://doi.org/10.1108/ITPD-02-2025-0007

Kenny, U., & Regan, Ã. (2021). Co-designing a smartphone app for and with farmers: Empathising with end-usersâ€™ values and needs. *Journal of Rural Studies*, *82*(Query date: 2025-09-09 22:06:53), 148–160. https://doi.org/10.1016/j.jrurstud.2020.12.009

Khan, N., Ray, R. L., Kassem, H. S., & Zhang, S. (2022). Mobile Internet Technology Adoption for Sustainable Agriculture: Evidence from Wheat Farmers. *Applied Sciences*, *12*(10), 4902. https://doi.org/10.3390/app12104902

Khanal, S., Bhattarai, S. B. S., Adhikari, U., Sharma, D., & Pandey, M. (2021). Disparities between developed and emerging economies in digital divide and ICT gap to bring agricultural sustainability. *Fundamental and Applied Agriculture*, *6*(3), 309–322.

Knitsch, V., Daniel, L., & Welz, J. (2024). Mapping varieties of farmersâ€™ experience in the digital transformation: A new perspective on transformative dynamics. *Precision Agriculture*, *25*(4), 1958–1981. https://doi.org/10.1007/s11119-024-10148-7

Kugbega, S. K., & Aboagye, P. Y. (2021). Farmer-herder conflicts, tenure insecurity and farmer's investment decisions in Agogo, Ghana. *Agricultural and Food Economics*, *9*(1), 19.

Lai, Y., Du, R., He, J., Zhou, J., & Yao, L. (2025). Vicious cycle or virtuous feedback? Revisiting the impact of climate risk on agricultural carbon emissions in China. *Climate Smart Agriculture*, *2*(3), 100065. https://doi.org/10.1016/j.csag.2025.100065

Langer, G., Schulze, H., & KÃ¼hl, S. (2024). From intentions to adoption: Investigating the attitudinal and emotional factors that drive IoT sensor use among dairy farmers. *Smart Agricultural Technology*, *7*(Query date: 2025-09-09 22:06:53), 100404. https://doi.org/10.1016/j.atech.2024.100404

Levin, I., & Mamlok, D. (2021). Culture and society in the digital age. *Information*, *12*(2), 68.

Li, C., Shi, Y., Khan, S. U., & Zhao, M. (2021). Research on the impact of agricultural green production on farmers' technical efficiency: Evidence from China. *Environmental Science and Pollution Research*, *28*(29), 38535–38551. https://doi.org/10.1007/s11356-021-13417-4

Li, L., Li, W., Zhang, M., & Liu, B. (2025). Study of vegetable farmersâ€™ IoT technology adoption decision making based on Heckman model. *Smart Agricultural Technology*, *11*(Query date: 2025-09-09 22:06:53), 101019. https://doi.org/10.1016/j.atech.2025.101019

Li, L., Min, X., Guo, J., & Wu, F. (2024). The influence mechanism analysis on the farmersâ€™ intention to adopt Internet of Things based on UTAUT-TOE model. *Scientific Reports (Nature Publisher Group)*, *14*(1), 15016. https://doi.org/10.1038/s41598-024-65415-4

Lim, W. M., Kumar, S., & Ali, F. (2022). Advancing knowledge through literature reviews:'what','why', and 'how to contribute.' *The Service Industries Journal*, *42*(7–8), 481–513.

Lin, D., Fu, B., Xie, K., Zheng, W., Chang, L., & Lin, J. (2023). Research on the Improvement of Digital Literacy for Moderately Scaled Tea Farmers under the Background of Digital Intelligence Empowerment. *Agriculture*, *13*(10), 1859. https://doi.org/10.3390/agriculture13101859

Liu, M., & Liu, H. (2024). Farmers' adoption of agriculture green production technologies: Perceived value or policy-driven? *Heliyon*, *10*(1).

Liu, W., & Liu, Y. (2022). The impact of incentives on job performance, business cycle, and population health in emerging economies. *Frontiers in Public Health*, *9*, 778101.

Liu, Y., Liu, G., Huang, L., Xiao, H., & Liu, X. (2025). Impact of Digital Infrastructure on Farm Households' Scale Management. *Sustainability*, *17*(15), 6788.

Lynch, J., Cain, M., Frame, D., & Pierrehumbert, R. (2021). Agriculture's contribution to climate change and role in mitigation is distinct from predominantly fossil CO2-emitting sectors. *Frontiers in Sustainable Food Systems*, *4*, 518039.

Mallick, S., Burman, R., Padaria, R., Mahra, G., Aditya, K., Shekhawat, K., Satyapriya, D., Paul, S., Sahu, S., Bishnoi, S., Singh, R., Manjunath, K., Saini, S., & Mukherjee, S. (2025a). Exploring farmers' psychological perspectives on multimedia-based agro-advisory services. *Scientific Reports*, *15*. https://doi.org/10.1038/s41598-025-92936-3

Mallick, S., Burman, R., Padaria, R., Mahra, G., Aditya, K., Shekhawat, K., Satyapriya, D., Paul, S., Sahu, S., Bishnoi, S., Singh, R., Manjunath, K., Saini, S., & Mukherjee, S. (2025b). Exploring farmers' psychological perspectives on multimedia-based agro-advisory services. *Scientific Reports*, *15*. https://doi.org/10.1038/s41598-025-92936-3

Marescotti, M. E., Demartini, E., Filippini, R., & Gaviglio, A. (2021). Smart farming in mountain areas: Investigating livestock farmersâ€™ technophobia and technophilia and their perception of innovation. *Journal of Rural Studies*, *86*(Query date: 2025-09-09 22:06:53), 463–472. https://doi.org/10.1016/j.jrurstud.2021.07.015.

Marius, M., Vanessa, B., & Oliver, M. (2020). Understanding the adoption of smartphone apps in crop protection. *Precision Agriculture*, *21*(6), 1209–1226. https://doi.org/10.1007/s11119-020-09715-5

Marmont, B., Eastwood, C., Minnee, E., Dorner, Z., Neal, M., & Silva-Villacorta, D. (2024). Predicting future adoption of early-stage innovations for smart farming: A case study investigating critical factors influencing use of smart feeder technology for potential delivery of methane inhibitors in pasture-grazed dairy systems. *Smart Agricultural Technology*, *9*(Query date: 2025-09-09 22:06:53), 100549. https://doi.org/10.1016/j.atech.2024.100549

Martoredjo, N. T. (2023). Social media as a learning tool in the digital age: A review. *Procedia Computer Science*, *227*, 534–539.

Masambuka-Kanchewa, F., Rumble, J., & Buck, E. (2021). Exploring differences in communication behaviors between organic and conventional farmers. *Journal of Agriculture, Food Systems, and Community Development*, *10*(3), 205–219.

McFadden, J., Njuki, E., & Griffin, T. (2023). *Precision agriculture in the digital era: Recent adoption on US farms*.
McKeown, S., & Mir, Z. M. (2021). Considerations for conducting systematic reviews: Evaluating the performance of different methods for de-duplicating references. *Systematic Reviews*, *10*(1), 38.
Mhlanga, D., & Ndhlovu, E. (2023). Digital technology adoption in the agriculture sector: Challenges and complexities in Africa. *Human Behavior and Emerging Technologies*, *2023*(1), 6951879.
Miine, L. K., Akorsu, A. D., Boampong, O., & Bukari, S. (2023). Drivers and intensity of adoption of digital agricultural services by smallholder farmers in Ghana. *Heliyon*, *9*(12). https://doi.org/10.1016/j.heliyon.2023.e23023
Mols, A. (2021). Digital literacy and information inequality in Dutch WhatsApp Neighbourhood Crime Prevention groups. *Criminological Encounters*, *4*(1), 223–228.
Munz, J., & Schuele, H. (2022). Influencing the Success of Precision Farming Technology Adoptionâ€”A Model-Based Investigation of Economic Success Factors in Small-Scale Agriculture. *Agriculture*, *12*(11), 1773. https://doi.org/10.3390/agriculture12111773
Mushi, G. E., Burgi, P.-Y., & Serugendo, G. D. M. (2024). State of Agricultural E-Government Services to Farmers in Tanzania: Toward the Participatory Design of a Farmers Digital Information System (FDIS). *Agriculture*, *14*(3), 475. https://doi.org/10.3390/agriculture14030475
Nafilyan, V., Dolby, T., Razieh, C., Gaughan, C. H., Morgan, J., Ayoubkhani, D., Walker, S., Khunti, K., Glickman, M., & Yates, T. (2021). Sociodemographic inequality in COVID-19 vaccination coverage among elderly adults in England: A national linked data study. *BMJ Open*, *11*(7), e053402.
Newton, J. E., Nettle, R., & Pryce, J. E. (2020). Farming smarter with big data: Insights from the case of Australia's national dairy herd milk recording scheme. *Agricultural Systems*, *181*(Query date: 2025-09-09 22:06:53), 102811. https://doi.org/10.1016/j.agsy.2020.102811
Nwachukwu, C. (2023). *Green agriculture and food security, a review*. *1178*(1), 012005.
Pastrana-Pastrana, Á. J., Rodríguez-Herrera, R., Solanilla-Duque, J. F., & Flores-Gallegos, A. C. (2025). Plant proteins, insects, edible mushrooms and algae: More sustainable alternatives to conventional animal protein. *Journal of Future Foods*, *5*(3), 248–256. https://doi.org/10.1016/j.jfutfo.2024.07.004
Piancharoenwong, A., & Badir, Y. F. (2024). IoT smart farming adoption intention under climate change: The gain and loss perspective. *Technological Forecasting and Social Change*, *200*(Query date: 2025-09-09 22:06:53), 123192. https://doi.org/10.1016/j.techfore.2023.123192
Ramadan, E., Abdalla, S., Ahbabi, A. A., Gibreel, T., & Hosani, N. A. (2025). Towards sustainable urban agriculture in the arid GCC states: Drivers of technology adoption among small-scale farmers. *City and Environment Interactions*, *28*(Query date: 2025-09-09 22:06:53), 100222. https://doi.org/10.1016/j.cacint.2025.100222
Rehman, A., Farooq, M., Lee, D.-J., & Siddique, K. H. (2022). Sustainable agricultural practices for food security and ecosystem services. *Environmental Science and Pollution Research*, *29*(56), 84076–84095.
Reissig, L., & Siegrist, M. (2025). From the attitude towards digitalisation in agriculture to the acceptance of future agricultural technologies. *Smart Agricultural Technology*, *12*(Query date: 2025-09-09 22:06:53), 101095. https://doi.org/10.1016/j.atech.2025.101095
Ren, Z., Fu, Z., & Zhong, K. (2022). The influence of social capital on farmers' green control technology adoption behavior. *Frontiers in Psychology*, *13*, 1001442.

Rivaldo, Y., & Nabella, S. D. (2023). Employee performance: Education, training, experience and work discipline. *Calitatea*, *24*(193), 182–188.

Santoso, A. B., Ulina, E. S., Batubara, S. F., Chairuman, N., Sudarmaji, Indrasari, S. D., Pustika, A. B., Sutrisna, N., Surdianto, Y., Rahmini, Aryati, V., Manurung, E. D., Purba, H. F. P., Senoaji, W., Kotta, N. R. E., Parhusip, D., Widihastuty, Mugiasih, A., & Tobing, J. M. L. (2024). Are Indonesian rice farmers ready to adopt precision agricultural technologies? *Precision Agriculture*, *25*(4), 2113–2139. https://doi.org/10.1007/s11119-024-10156-7

Selvaggi, R., Zanchini, R., ZarbÃ, C., Pecorino, B., & Pappalardo, G. (2024). Simultaneous evaluation of dairy farmers' behaviour and intention to adopt technological devices. *Aestimum*, *84*, 3–17. https://doi.org/10.36253/aestim-15362

Setsoafia, E. D., Ma, W., & Renwick, A. (2022). Effects of sustainable agricultural practices on farm income and food security in northern Ghana. *Agricultural and Food Economics*, *10*(1), 1–15.

Shih, S., & Chiu, B. (2023). Willingness of Farmers to Adopt Blockchain Technology in Smart Agriculture. *Journal of Economics, Finance, and Accounting Studies*, *5*(4), 24–34. https://doi.org/10.32996/jefas.2023.5.4.3

Silveira, F. da, Silva, S. L. C. da, Machado, F. M., Barbedo, J. G. A., & Amaral, F. G. (2023). Farmers' perception of the barriers that hinder the implementation of agriculture 4.0. *Agricultural Systems*, *208*(Query date: 2025-09-09 22:06:53), 103656. https://doi.org/10.1016/j.agsy.2023.103656

Spykman, O., Gabriel, A., Ptacek, M., & Gandorfer, M. (2021). Farmersâ€™ perspectives on field crop robots â€" Evidence from Bavaria, Germany. *Computers and Electronics in Agriculture*, *186*(Query date: 2025-09-09 22:06:53), 106176. https://doi.org/10.1016/j.compag.2021.106176

Sun, R., Zhang, S., Wang, T., Hu, J., Ruan, J., & Ruan, J. (2021). Willingness and Influencing Factors of Pig Farmers to Adopt Internet of Things Technology in Food Traceability. *Sustainability*, *13*(16), 8861. https://doi.org/10.3390/su13168861

Taheri, F., Dâ€™Haese, M., Fiems, D., & Azadi, H. (2022). Facts and fears that limit digital transformation in farming: Exploring barriers to the outreach of wireless sensor networks in Southwest Iran. *PLoS One*, *17*(12). https://doi.org/10.1371/journal.pone.0279009

Tian, M., Deng, P., Zhang, Y., & Salmador, M. P. (2018). How does culture influence innovation? A systematic literature review. *Management Decision*, *56*(5), 1088–1107.

Tran, D. T., Duong, M. T. D., & Hoang, H. G. (2025). Perception and factors affecting farmersâ€™ adoption of smart agriculture in Vietnam: Implications for extension strategies. *World Development Perspectives*, *38*(Query date: 2025-09-09 22:06:53), 100691. https://doi.org/10.1016/j.wdp.2025.100691

Uehleke, R., Plettenberg, L. von, Leyer, M., & HÃ¼ttel, S. (2024). German sugar beet farmersâ€™ intention to use autonomous field robots for seeding and weeding. *Journal of Environmental Management*, *370*(Query date: 2025-09-09 22:06:53), 122472. https://doi.org/10.1016/j.jenvman.2024.122472

Vadivel, B., Alam, S., Nikpoo, I., & Ajanil, B. (2023). The impact of low socioeconomic background on a child's educational achievements. *Education Research International*, *2023*(1), 6565088.

Vo, C. Q., Samuelsen, P.-J., Sommerseth, H. L., Wisløff, T., Wilsgaard, T., & Eggen, A. E. (2023). Comparing the sociodemographic characteristics of participants and non-participants in the population-based Tromsø Study. *BMC Public Health*, *23*(1), 994.

Wang, W., Huang, Z., Fu, Z., Jia, L., Li, Q., & Song, J. (2024). Impact of digital technology adoption on technological innovation in grain production. *Journal of Innovation & Knowledge*, *9*(3), 100520. https://doi.org/10.1016/j.jik.2024.100520

Wang, Y.-J., Wang, N., Li, M., Li, H., & Huang, G. Q. (2024). End-users' acceptance of intelligent decision-making: A case study in digital agriculture. *Advanced Engineering Informatics*, *60*(Query date: 2025-09-09 22:06:53), 102387. https://doi.org/10.1016/j.aei.2024.102387

Wibowo, S. (2024). Innovative strategy for the application of discretion in government policy in Indonesia: An analysis. *Gorontalo Law Review*, *7*(1), 69–84.

Zeddies, H. H., Busch, G., & Qaim, M. (2024). Positive public attitudes towards agricultural robots. *Scientific Reports*, *14*(1), 15607.

Zhang, X., Yang, Q., Mamun, A., Masukujjaman, M., & Masud, M. (2024). Acceptance of new agricultural technology among small rural farmers. *Humanities and Social Sciences Communications*, *11*. https://doi.org/10.1057/s41599-024-04163-2

Zhou, X., Chen, T., & Zhang, B. (2023). Research on the impact of digital agriculture development on agricultural green total factor productivity. *Land*, *12*(1), 195.