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Systematic Literature Review: An overview of Digital Agriculture for Food Sustainability

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ABSTRACT

Purpose: Digital agriculture has been noted to have far reaching prospects in the transformation of agribusiness. Digital technologies are been applied to improve food production, processing, security and packaging. As most of the least developed and developing economies are strategizing to reduce poverty and hunger, digital agriculture presents opportunities to reverse the trends. Thus, this paper presents a systematic literature review with aim to collect all related research and identify gaps in digital agriculture, as well as to understand the benefits of digital technology in agriculture in other to chart new proposition for future studies.

Design/methodology/approach: A systematic literature review was carried, and we have extracted 67 journals published within the last two decades (2002 -2022).

Findings: Findings suggests that digital agriculture is important drivers of food sustainability, with improve production yield and increase household income. Also, 42% of the studies on digital agriculture are dominated by precision agriculture model. This SLR recognizes knowledge gaps in relation to the context, theory and content for future research.

Originality/value: This paper is original

Paper type: a Research Paper

Keywords: *sustainability, digital, agriculture, smart farm, agribusiness clusters*

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I. INTRODUCTION

Agriculture and food sustainability are part of the most important aspect of the global world. International organization and agencies are striving to improve food productivity, security and sustainability in a healthy environment. Moreover, farmers and agribusiness enterprises are adopting different information and communication technology (ICT) facilities such as image sensors, big data, internet of thing (IoT), smartphones, drones, robotics and many others in other to improve yield in the agriculture processes.

Over the last decades, a wide range of scholarly work has been released on digital agriculture (V. Kumar et al., 2008; Nazarov et al., 2019; Saberioon et al., 2013; Srinivasan & Koteeswaran, 2016; Teucher et al., 2022; Vigoroso et al., 2021; Yong et al., 2002). Digital agriculture is the termed used to describe the transformation of agricultural practices, processes, products and marketing by using the ICT infrastructures to improve yield and decision making as well as reduce production cost, food shortage and wastages throughout the value chain (Fountas et al., 2020; Kosareva et al., 2019). It is the exploitation of digital technologies in agribusiness and its management which have been adopted in other sector of the economy such as finance (fintech) (Anshari et al., 2019), publishing (Li et al., 2014) and education (Herdon et al., 2015).

Agribusiness or agropreneurs, mostly unincorporated business firms (Chung et al., 2021), predominantly in rural areas Bowen & Morris (2019) operating in the agricultural sector of the economy. They represent most of

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the SMEs that contribute substantially to the development of developing and less developed economy in comparison with the developed economies (Bowen & Morris, 2019; Ravis & Notkin, 2020).

Digital agriculture provides opportunities to entrepreneurs' farmers to position their business for better performance using digital structures. Such opportunities as access to market (e-commerce/e-market), new knowledge and skills, better communication, product development, access to financing (crowdfunding), collaboration with others in the same sector (social media) and access to new machineries (Chung et al., 2021; Giles & Stead, 2021). Digital agriculture have been noted to address the food production and logistics challenges in developing economies in the face of rapidly growing population while maintaining other vices such as food quality, green environment (Cook et al., 2021) and prices, especially the menace of middlemen along the value chain of food supply.

Therefore, it is pertinent to identify and understand what areas related to digital agriculture have been studied and addressed by researchers. The current biggest benefits, challenges, impacts and limitations that need to be discussed by future studies. To provide sense of direction for future research, we provide systematic literature review on digital agriculture. This review objective is to create a path of what is know on digital agriculture and to propose a research agenda. To these ends, we presented SLR of 67 journals published between 2002 and 2022. Although, there are several studies that present systematic literature review on some digital technologies used in agriculture, but there is none on digital agriculture.

Our review is organized as follows: section 2 explain the research methodology- review method and database search and identified journals analysis. Then section 3 presents the results in relation to the theme, theories used, and entrepreneurial model of journals reviewed. After that, directions for further studies opportunities suggested.

II. RESEARCH METHODOLOGY

The main objective of this systematic literature review (SLR) is to detect relevant literature in digital agriculture (DA). This study adopted Aromataris & Pearson (2014); Denyer & Tranfield (2009) based on medical research methodology of SLR. This research review provides an unbiased, and reproductive process which include identifying, synthesizing and analyzing scholarly journals through extensive searches of databases and applying inclusion as well as exclusion criteria that conform with the research objectives. Figure 1 provides the summary of the steps taken to prepare this review.

A progressive system of searching, analyzing, reviewing and synchronization of literature was applied to this research (Aromataris & Pearson, 2014). The search and selection criterial for selection of journals used in this SLR is detailed in Table 1. Keyword search of the term 'digital agriculture', digital and food sustainability and digital agribusiness in "titles only". The search strategy adopted firstly was to identify journals digital database and web sources. The database selected include Elsevier, Sage, Springer, Taylor & Francis, Wiley and Google Scholar for the web libraries.

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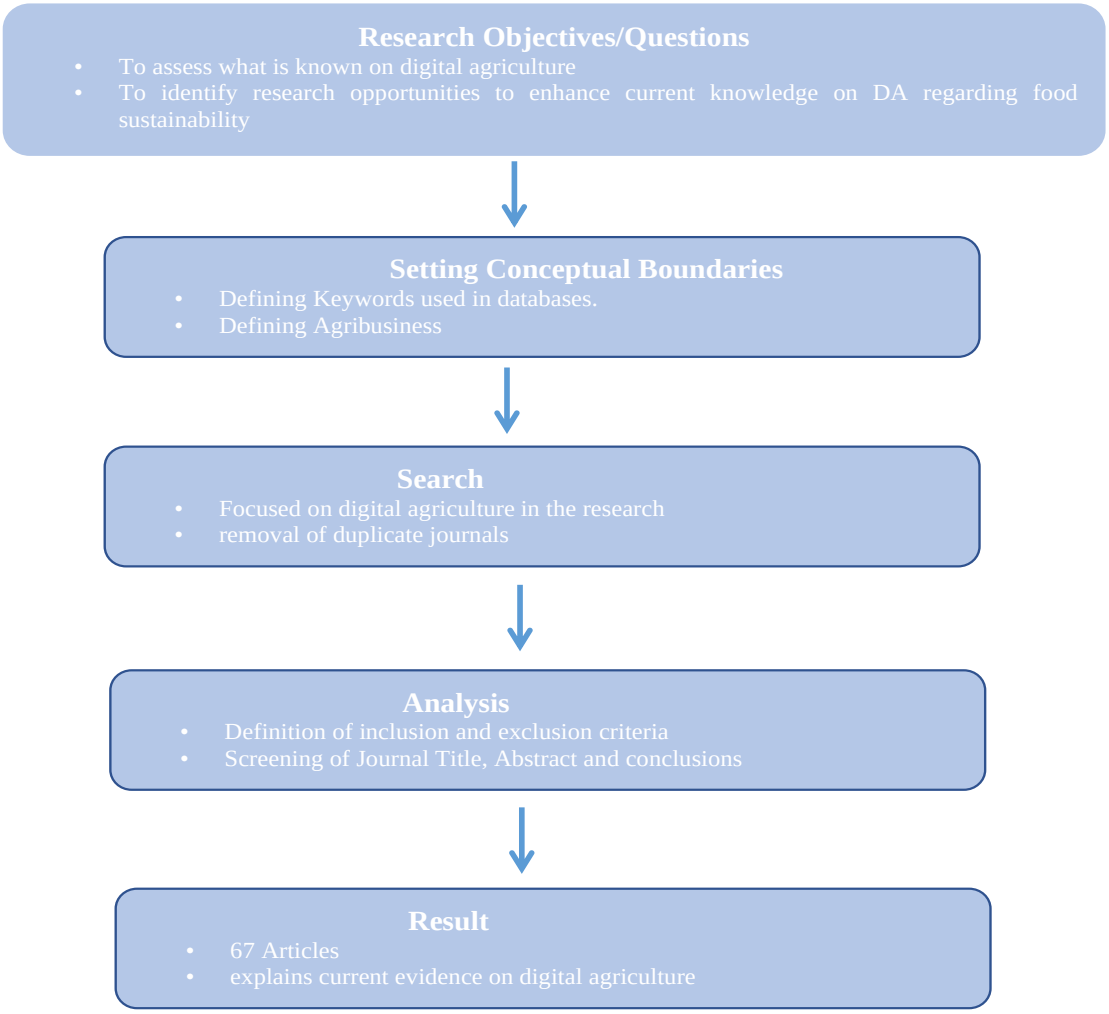

Figure 1. Summary of SLR process

Table 1: Selection Criteria.

Criterion	*Inclusion*	*Exclusion*	*Justification*
Relevance to the objectives	*Journals with focus on both digital technology and agriculture. Research with focus on digital innovation and included agribusiness in research.*	*Papers without core focus on digital and agriculture*	*To provide information that will aid in answering the review questions.*
Language of Publication	*English*	*All other languages*	*Research team constrains*
Date of Publication	*Up to February 2022*	*None*	*No restrictions*
Databases	*Elsevier, Sage, Springer, Taylor & Francis, Wiley and others*	*Articles that are not available on Scopus are removed*	*To provide quality assessment for Journal used*

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Type of Publication	*Peer-reviewed journal articles*	*Books, theses, book chapter, reports, working papers; press articles*	*These were excluded due to limited peer review process*
Types of Research	*Theoretical, Empirical and Literature review*	*None*	*All types were used*
Disciplines	*All subject areas*	*None*	*Most of the research reviewed either published in IT, Management, Entrepreneurship or Agriculture discipline.*

An analysis template was used to extract basic information on examined variables and relationships. A deductive approach was used to analyze the journals downloaded. In order to achieve the set objectives of this review, data extracted includes publication title, authors, year of publication, main contribution of the research and findings applicable to digital agriculture. Table 2 provides a general perspective of most study selected. Most studies were published in the year 2021 which shows that digital agriculture is growing research area. The most recent years of publication is represented in Figure 2.

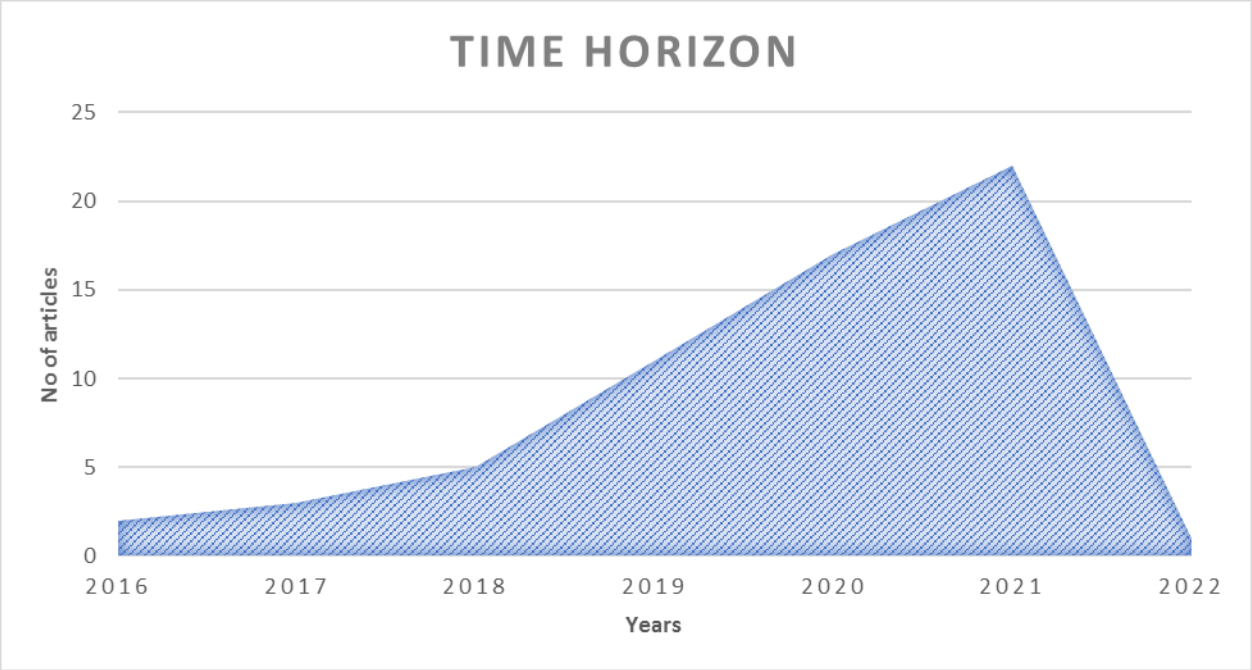

Figure 2: Years of Publication

Table 2: General perspective of study area

Research Work	*Database*	*Objective*
(Yong et al., 2002)	*Springer*	*Provides introduction to digital technology content, purpose and its importance as well as the challenges of using DA.*

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(V. Kumar et al., 2008)	*Elsevier*	*Design and implement a model to enable users efficiently manage agriculture research photo archives.*
(Small, 2017)	*Google Search*	*Employ the 3D model (detect, develop and deploy) in the use of technologies for agricultural enterprises. Explore new and emerging technologies in IoT, AI, virtual reality, remote sensing, robotics, drones and driverless vehicles.*
(Santiago et al., 2018)	*Wiley*	*Insights into the importance of education to solve the food sustainability issue and discuss challenges in food logistics.*
(Klerkx et al., 2019)	*Elsevier*	*Provide overview of how the digital agriculture evolving – from established through emerging ad* *Nd new topics in smart farming, agriculture 4.0 and precision farming.*
(Carolan, 2020)	*Taylor & Francis*	*To provide enough clarity on the use of automation skills rather than just the determining the terminologies in digital agriculture.*
(Bowen & Morris, 2019)	*Elsevier*	*Investigate the impact of broadband access by the rural farmers and their entrepreneurial activity. Poor connectivity was noted to a major challenge in internet connectivity in the rural area.*
(Lajoie-O'Malley et al., 2020)	*Elsevier*	*Provide information on the roles of international organizations in policy formulation regarding the use of digital technologies in food supply.*
(Runck et al., 2021)	*Wiley*	*Provide the taxonomy of DA using a bottom-up and top-down approach.*
(Cook et al., 2021)	*Taylor & Francis*	*Provide a frameworks domain that include digital technologies in agricultural and food system (production, capitals, market, governance and digital technologies).*
(Ggiles & Stead, 2021)	*Springer*	*Evaluate the importance of Big data technology in global food system and smallholders.*
(Teucher et al., 2022)	*MDPI*	*Analyze remote sensing as a digital solution for agricultural management that involve acquisition, processing and dissemination of agribusiness information.*

III. RESULTS

In this section, we present the outcome of systematic review analysis on the examined digital agriculture, theories supporting digital technologies in agribusiness and agro-industrial cluster research, research background directions and the current focus of scholars in this field.

A. Digital Agriculture

Quite a few information technology structures were examined in the systematic literature review. Table 3 highlighted the digital infrastructure focus of researchers from the articles reviewed. The top three focus by researchers were artificial intelligence (30%, 45 articles), ICT (25%, 37 articles), and enterprise management systems (19%, 29 articles). Others area of focus by researcher are internet (15%), e-commerce (5%), and other technologies (7%). E-commerce system including e-learning, e-skill, crowdfunding, FinTech were examined by limited number of researches possibly due to the growing of the growing in digital agribusiness. New

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technologies in agricultural business such as big data analytics, remote sensing, 3D, wireless sensor network have been recently gaining more attention from researcher as well as public users. In this study, Internet have been reviewed as a bucket that consist terms such as Internet of Things (IoT) (Fountas et al., 2020; Rijswijk et al., 2019; Sott et al., 2021), Wi-Fi and Bluetooth (Sarkar & Chanagala, 2018), broadband (Bowen & Morris, 2019). It is pertinent to note that researchers study a group of digital infrastructures that share the same features. See for example: virtual or cloud computing (Gill et al., 2017; Molin et al., 2021), global positioning system (GPS), geographic information system (GIS) and Unmanned Aerial Vehicle (UAV) (Himesh et al., 2018; Lajoie-O'Malley et al., 2020; Potgieter et al., 2021).

Over the past two decades, researchers have focused on examining the consistent improvement of digital infrastructures in agribusiness in bid to enhance food sustainability as the world population increases. By examining the application of digital photo camera (V. Kumar et al., 2008) to virtual reality imagery (Small, 2017), to wireless sensor network (Chaterji et al., 2020) and more recently robotics and drones (Pauschinger & Klauser, 2021) as well as agriculture 4.0 (Rijswijk et al., 2019) for improvement in agribusiness mechanization.

Table 3: Digital technologies and infrastructure

Digital Infrastructure	*Terminologies*	*Percentage*	*References*
Artificial Intelligence	*Machine Learning, robotic, blockchain, AI, drones*	*30%*	*Small (2017); Klerkx et al. (2019); Zeraatpisheh et al. (2020); Potgieter et al. (2021)*
ICT	*ICT, Digital Technology, Global Positioning System, GIS*	*25%*	*Yong et al. (2002); Kumar et al. (2008); Kosareva et al. (2019); Fountas et al. (2020)*
Enterprise Management System	*Bid Data Analytics, DSS, Digital Sequence Information, Farm Management Information System*	*19%*	*Himesh et al. (2018); Reis et al. (2020); Bolfe et al. (2020)*
Internet	*IoT, Wi-Fi, broadband*	*15%*	*Sarkar et al. (2016); Bowen & Morris (2019); Jabir & Falih (2020)*
E-commerce	*E-learning, e-skills, crowdfunding, FinTech, Digital Marketplace*	*5%*	*Herdon et al. (2015); Anshari et al. (2019); Vigoroso et al. (2021)*
Others	*Coding, Solar panel, radio, agriculture 4.0*	*7%*	*Santiago et al. (2018); Klerkx et al. (2019); Silvestri et al. (2021)*

B. Underpinning Theories

The analysis of the digital agribusiness studies reviewed indicates twenty theories were used to describe the application and impact of digital technology in agriculture. Although, a significant number of journals (44 journals) did not employ any theory. Early research used Object-oriented theory (Yong et al., 2002), technological disruption (Small, 2017), diffusion of innovation Nitturkar (2021) that explore the innovation activities within digital agriculture and agribusiness. As these innovative disruptions can create misperception when explaining to farmers and agropreneurs, hence the need for more understanding of these theories. Researchers have however combined Theory U Santiago et al. (2018) and information entropy theory Markovic et al. (2018) to examine the changes in the current process in order to determine the effect on the future activities. This broad spectrum of digital agribusiness concept allows scholars to discuss theories that explained the entrepreneurs' goal in the evolution, acquisition, adoption and implementation as well as the resultant impact on food sustainability as envisioned by the United Nation in its sustainable development goal (SDG). Entrepreneurship theory Bowen & Morris (2019) was used to examine the implication of digital technologies such as broadband and internet connectivity on entrepreneurial activities among the small and medium

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enterprises that dominate the world economy, especially in agribusiness ventures. The effect of the transformation in agribusiness through the digital innovation was analyzed using the complimentary theory by (Medennikov, 2020). It found that the complimentary effort of investment in digital technologies and the human aspect create a positive contribution in society. Other studies also provide insight into this relationship using human-centered system theory (Somers & Stapleton, 2020); theory of human behavior (Giles & Stead, 2021); labor process theory (LPT) (Prause et al., 2021), and social practice theory (Heidenstrøm & Hebrok, 2021).

Other theories employed by scholars in this review are assemblage theory (Klerkx et al., 2019); globalization theory (Ravis & Notkin, 2020); economic theory (Birner et al., 2021; Shogentsukova & Shogentsukov, 2020) and corporate social responsibility theory (Ebrahimi et al., 2021).

C. Geographical Distribution

Based on the www.worlddata.info country classification, six continents were covered by our sample reviewed and 32 countries around the world (as shown in Figure 3). Europe has the most published articled (32) followed by Asia (17) and North America (9). Other continent had – Australia (7), South America (6) and the least studied area is Africa (5). Oceania had no representation in the reviewed articles.

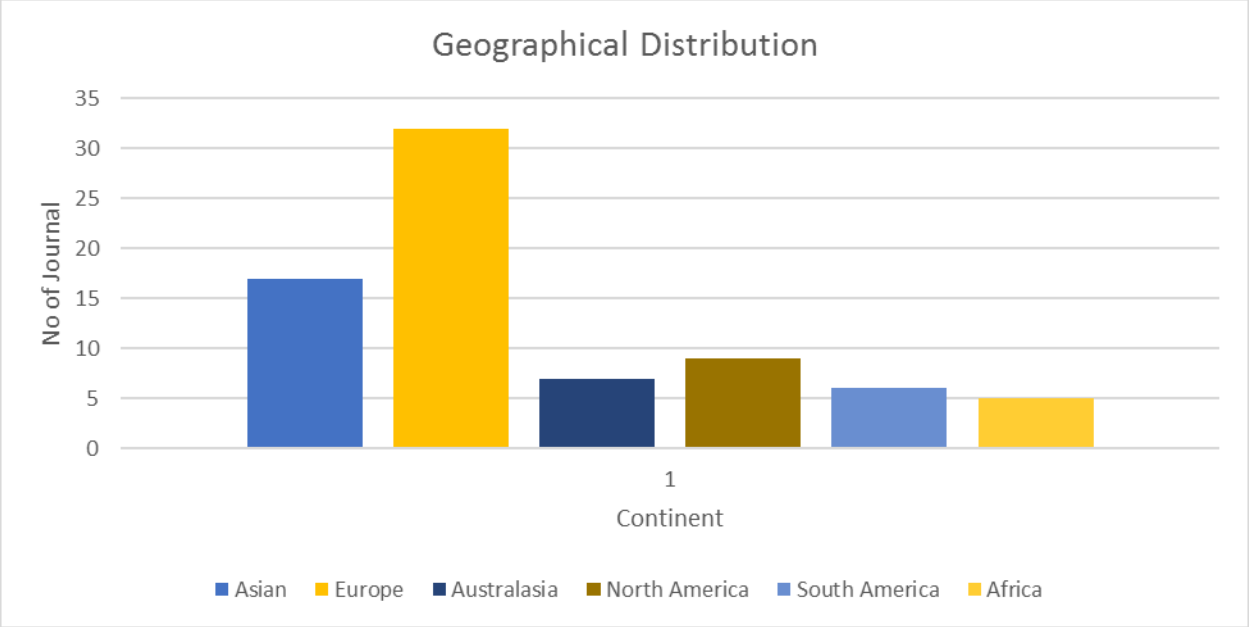

Figure 3: Geographical distribution of the study

In economies term as depicted by Table 4, developed economies had the highest published journal (52%) while developing economies had 48% and none of the studies covered the less developed economies. Based on this classification, earlier studies were carried out in developing countries focusing on India (V. Kumar et al., 2008; Sarkar & Chanagala, 2018), China (Yong et al., 2002) and Malaysia (Saberioon et al., 2013). A few studies cover countries such as Egypt (Afifi et al., 2014), Serbia (Markovic et al., 2018), Wales (Bowen & Morris, 2019) and Norway (Heidenstrøm & Hebrok, 2021). However, the analysis revealed that there is still much work for scholars to unearth in digital technologies and agriculture in the less represented region, especially the less developing economies.

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Table 4: Economies distribution of the study

Economies (number of studies)	*Countries (Number of occurrence)*
Developed Economies (39)	
Europe (21)	*Germany (4); Netherland (3); UK (2); Ireland (2); France (1); Italy (2); Switzerland (2); Norway (1); Belgium (1); Wales (1); Hungary (1)*
North America (9)	*United State of America (7); Canada (2)*
Australia (7)	*Australia (5); New Zealand (2)*
Asia (2)	*Japan (2)*
Developing Countries (36)	
Asia (14)	*India (6); China (5); Malaysia (1); Iran (1); Indonesia (1)*
Europe (11)	*Russia (8); Romania (1); Serbia (2)*
South America (6)	*Brazil (6)*
Africa (5)	*Nigeria (1); Egypt (1); Morocco (1); Kenya (1); Tanzania (1)*

D. Content

Having considered the result on the digital agriculture, the underpinning theories employed in studies and geographical evidence in the research, findings regarding the contextual emphasis of the journals analyzed is presented below:

1. Digital Agriculture Technology Development

Twelve percent (12%) of the articles reviewed by this study analyzed the evolution, acquisition and innovation of digital technologies in agribusiness. Basically, researchers examine issues facilitating or hampering the development of digital technology for improvement in food production and sustainable agriculture. The development of a visual map to access all potential agriculture area for optimal use of land was the focus of Afifi et al. (2014). By employing digital technology such as GIS, remote sensing and digital camera, farmers will be able to enhance food production by determining the features and texture of soil for planting as well as observing urban encroachment that may hinder soil fertility. In similar fashion, (Gill et al., 2017; Himesh et al., 2018) develop a model to delivery of service quality for agriculture business using the IoT, sensor technologies and big data analytical system with information store in the cloud- a cloud based automatic information system. Small (2017) noted that the emergence of digital technologies has revolutionized agribusiness sector by providing efficient service through computer-based technologies, and this will impact positively on the agribusiness value chain, most importantly to rural enterprises and SMEs.

2. Digital Agriculture Technology Implementation

Majority (54) of the articles reviewed focused on the adoption, implementation and adaption of digital technologies in agribusiness. The fast-changing structure in ICT world and the need to adapt its use for food sustainability, (Herdon et al., 2015) suggested the important factor e-learning posed to bridging the digital gap in agribusiness especially in the rural settlement. Internet penetration, networking and broadband (Bowen & Morris, 2019) as well as the antecedent service for the deployment of digital solution require honing the skills of

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farmers. Increasing food production yield and food safety using digital technologies were noted to be important precursor to food sustainability (Markovic et al., 2018; Potgieter et al., 2021; Tao & Bullock, 2019). However, due to the vast amount of information needed in agribusiness to make informed decision as a result of increase in world population and demand for more food, digital transformation and adaptation using big data analytic, robotic and drone technology are deemed necessary for agriculture enterprise (Bolfe et al., 2020; Giles & Stead, 2021; K. K. Kumar, 2020).

Digital technology in agriculture starts the basic need of farming – the soil. Sarkar & Chanagala (2018); Zhou et al. (2017) noted that the replacement of the traditional and manual method of measuring as well as monitoring of soil Ph value, humidity and temperature with internet of things (IoT) and remote sensing imagery has speed up the farming activities due to the use of remote operation allows by wireless network. Bowen & Morris (2019) acknowledged the importance of broadband not only in communication, but also in growth and innovation of small enterprise, especially in farming. AgriTech, a global change in farm practice that has created opportunities for agribusiness, albeit with threats, also provides for ecological sustainability, improved welfare (Small, 2017), driving force in economic revolution (Srinivasan & Koteeswaran, 2016) and promote good governance (Jabir & Falih, 2020).

Other studies investigated the different aspect in the application of digital technologies in agriculture in relation to the role of research and development (Romani et al., 2020), agribusiness management and stakeholder (Ebrahimi et al., 2021; Shogentsukova & Shogentsukov, 2020), infrastructure (Bernhardt et al., 2021), and social sustainability use of resources (Prause et al., 2021; Teucher et al., 2022). There is no gainsaying that agriculture is the backbones of most developing countries and adoption of digital technologies in the production and processing as well as through the value chain will enhance greatly food productivity (Sott et al., 2021). Entrepreneurial system such as smart farming, precision agriculture and agroclusters among others have been introduced into agribusiness (Carolan, 2020; Potgieter et al., 2021; Small, 2017). However, less attention has been given to the process of penetration of digital technologies in rural settlement due to its infrastructure cost, especially in the developing countries. More so, awareness or learning need to be created in transforming form acquisition to adoption of digital technologies in agribusiness. Also, the relationship between stages and different infrastructure available for implementation.

Table 5: Digital agriculture stages

Theme	*References*
DigiTech Development	*Afifi et al. (2014); Small (2017); Zhou et al. (2017) Sunoj et al. (2018); Aubry (2019); Ebrahimi et al. (2021)*
DigiTech Implementation	*Saberioon et al. (2013); Small (2017); Zhou et al. (2017); Kosareva et al. (2019); Clapp and Ruder (2020); Somers and Stapleton (2020); Runck et al. (2021); Ebrahimi et al. (2021); Silvestri et al. (2021); Nitturkar (2021); Cook et al. (2021)*
DigiTech Impact	*Saberioon et al. (2013); Small (2017); Fountas et al. (2020); Suresha (2019); Silvestri et al. (2021); Nitturkar (2021); Cook et al. (2021)*

3. Digital Agriculture Technologies Impact

The next explored theme of the reviewed articles investigated the impact of the digital technologies' application on agribusinesses. The overall expected benefit of digital agribusiness innovation is to have incremental impact on food sustainability to reduce world poverty (Small, 2017) and digital agribusiness have proven- to some extent to solve this global challenge (Heidenstrøm & Hebrok, 2021). For example: Molin et al., (2021); Saberioon et al. (2013) noted that proper measuring and monitoring of soil nutrient create avenue for efficient precision crop management for different growth stages by investigating the effect of digital camera in crop production through estimation of nitrogen in the soil (Saberioon et al., 2013) and specific site management through precision agriculture (Cook et al., 2021; Molin et al., 2021) respectively. As the source of labour and income of most developing countries, digital agribusiness is posed to facilitate the increase in productivity, income and employment (Fountas et al., 2020; KP, 2019; Yiyan et al., 2020).

Medennikov (2020) highlighted the impact of digital agribusiness transformation on competitive advantage of SMEs that can be enhance by increasing investment in the use of digital technology that aim in enhancing the

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activities of both human and organizational assets. Especially in the agro-industrial clusters (Medennikov, 2020). On the other hand, Small (2017) observed the need for caution in the implementation of digital agribusiness against disruptive innovation systems to current food production and sustainability. Hence, the need for policy support in the face of fast pace digital transformation for SME agribusinesses (Bowen & Morris, 2019).

Several empirical studies explore both the adoption and the impact stages of digital technologies in agriculture (Heidenstrøm & Hebrok, 2021; Ravis & Notkin, 2020; Saberioon et al., 2013; Santiago et al., 2018; Silvestri et al., 2020; Yiyan et al., 2020) as shown in Table 5. While one article investigated digital agriculture across the three themes of developing, implementation and future impact on rural economic growth. Other benefits of digital agriculture over the traditional method is also noted in copyright protection in agriculture publishing (Li et al., 2014), the role of academia (Santiago et al., 2018) and media advertising (Chung et al., 2021).

As highlighted by Fountas et al. (2020); Small (2017) the numerous challenges and limitations may hinder the achievement of the expected benefits. Such challenges as data availability and accuracy, reluctance attitude of rural farmers, inadequate access to digital technology facilities and penetration cost need to empirically investigated especially in the developing countries. It thus not surprising that no digital agriculture article investigated the less develop countries that have agribusiness as their primary economic activity. This lack of attention given to these stakeholders by scholars present an important research gap for thorough investigation.

E. What are Entrepreneurial Activities in Digital Agriculture?

7. Digital Agriculture as an Entrepreneurial Activity Enabler

The Schumpeter's theory of entrepreneurship of 1949 expresses that business ventures are dynamic and are engine room for growth and development of economy through innovation of new products and services, new market and improvement on the existing process or organizational structure (Mehmood et al., 2019). However, using information and communication technology to create value addition in the process of creating new product or services by disrupting current process and creating new ones in agribusiness with the power of digital technologies (Amadi et al., 2021). Bowen & Morris (2019) noted the importance of digital agriculture for new agribusiness as well as act as an enabler for entrepreneurial mindsets.

The articles reviewed, therefore highlighted the emergence of four main entrepreneurial system in agribusiness: (1) Precision Farming; (2) Smart Farming; (3) Urban Farming; and (4) Agro -Industrial Cluster. Figure 4 presents the categorization of the entrepreneurial activities.

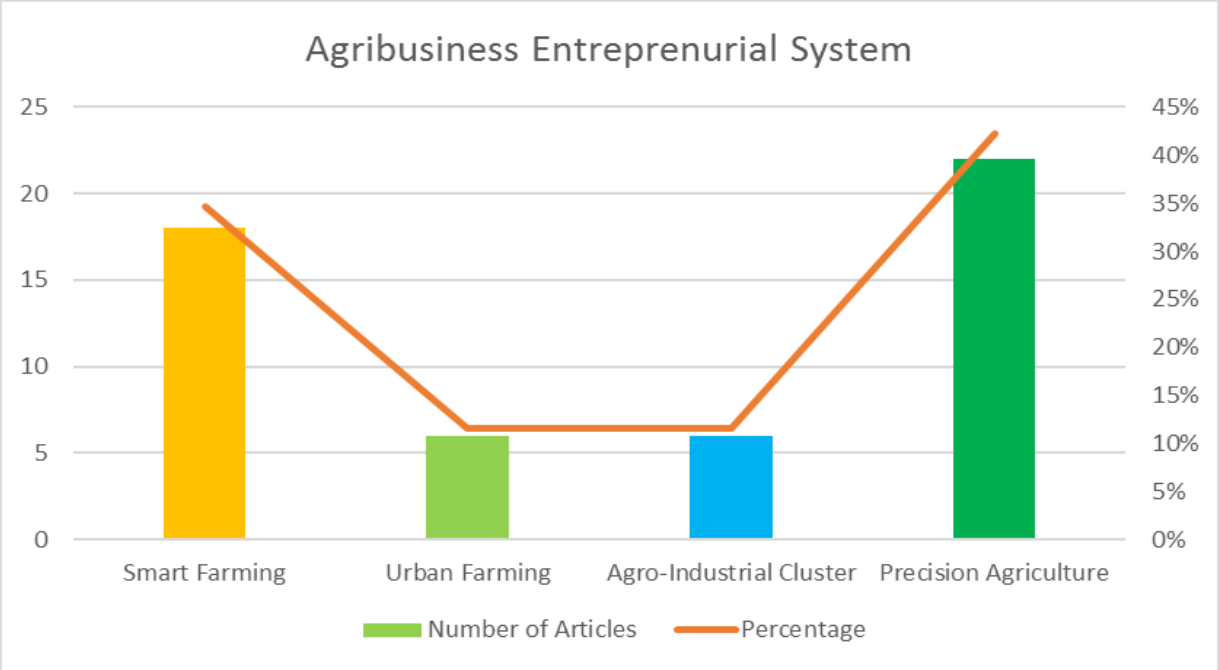

Figure 4: Entrepreneurial model of digital agriculture

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a. Precision Agriculture

The analysis of Digital Agriculture (DA) articles reviewed for this study revealed that 42% (22 articles) discusses the precision agriculture as model of agribusiness to improve productivity, efficiency, increase food sustainability and reduce world hunger (Carolan, 2020). Digital technologies are tools adopted by enterprises to help in precise management of agribusiness information in order to reduce cost of production and maximize benefits (Cook et al., 2021; Himesh et al., 2018; KP, 2019; Ravis & Notkin, 2020). Klerkx et al. (2019) reviewed literatures on digital technologies – such as Iot, big data, sensors, robotic, artificial intelligence (AI) employed in precision farming or precision agriculture as regard food productivity, food systems and its value chain. Earlier Saberioon et al. (2013) had developed a precision agriculture model (using sensors and big data) for rice farmers in a bid to improve production through the application of the right quantity of fertilizer and reduce cost of production.

Precision agriculture, an emerging digital agriculture technology which allows the adjustment of farm input in consideration of field soil resulting in improve production efficiency (KP, 2019). Although, Bolfe et al. (2020; Cook et al. (2021) noted that the precision agriculture innovation has been around for a while but has seen tremendous growth due to its benefits. However, achieving success in the practice does not based solely on the use of the precision farming technique, rather any misuse of the digital infrastructure will affect the expected gains (Cook et al., 2021).

b. Smart Farming

Smart Farming has been analyzed in the digital agriculture literature to describe an entrepreneurial activity by SMEs or individual as the implementation of the best agribusiness practices and procedures for efficient management of resources for food sustainability and production in the face of climate change (Himesh et al., 2018; Sott et al., 2021). From reviewing the extant literature, smart farming requires the deployment of digital technologies into agriculture production, processing and marketing as well as across the value chain in a way to maximize the use of available resources. These are transformation away from the traditional method to the use of UAV (Unmanned Aerial Vehicles), Machine learning, geospatial technology in agriculture (Sott et al., 2021), big data analytic (Bernhardt et al., 2021), internet and broadband access (Bowen & Morris, 2019), cloud computing (Bolfe et al., 2020) and software driven management system (Pauschinger & Klauser, 2021).

There has been consistent growing interest in the use of information and communication technologies to improve the efficiency in the agribusiness processing by farmers and policymakers (Klerkx et al., 2019). Whereas some scholarly contribution to the importance and benefits of smart farming include enhance the cycle of farm to table concept (Himesh et al., 2018) and reduces uncertainties in food production and increase efficiency (Pauschinger & Klauser, 2021), others emphasize the socio-economic development (Bolfe et al., 2020), transition from and reduction human labour (Shogentsukova & Shogentsukov, 2020) as the functions will be taken over by digital technologies such as sensors, digital camera and coding. Rijswijk et al. (2021) however noted digital technology innovation and development around smart farm have neglected the socio-ethical perspective. The new emerging development in smart farming requires the use of verse amount of data that can be shared between business partners (Bernhardt et al., 2021), this pose the threat to data usage. Unauthorized access to data may lead to hacking or unauthorized used of information. This area presents a research gap on the methods in securing and protecting agribusiness data to competitors.

c. Urban Farming

The first least discussed digital agricultural system described by the articles reviewed was Urban Framing. This concept of farming emanated from the importance of healthy lifestyle and eating healthy by working populace as well as the outcome of transformation from the physical agriculture to more intelligent agribusiness with aid of ICT. Other name used to describe this system of agribusiness includes vertical agriculture, urban agriculture and greenhouse farming (Klerkx et al., 2019).

The digital agriculture trend ongoing is adding to the urban-rural divide in agribusiness (Afifi et al., 2014). The increase in investment in information and communication technology in the urban area with little attention to the rural areas where most commercial farming is carried out is widening the urban-rural development (Bowen & Morris, 2019). Although, Bowen & Morris (2019) noted that the digital transformation also widened the urban-rural divides in most economy.

The opportunities of urban farming regarding inadequate land space, deforestation and efficient use of backyard space was not highlighted and thus pose a research gap for future research on digital agribusiness enterprises.

d. Agro-industrial cluster

This is the least discussed entrepreneurial system paradigm of digital agribusiness and five out of the six reviewed journals were of Russia origin (Aleksandrov et al., 2021; Amirova et al., 2018; Kosareva et al., 2019;

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Medennikov, 2020; Shogentsukova & Shogentsukov, 2020). Amirova et al. (2018) emphasized the importance of digital agribusiness in an agro-industrial cluster as an entrepreneurship system that can create a competitive advantage for the economy and improve business processes greatly.

Digital agriculture provide a leveraging engine for small and medium enterprises, especially in a agro-cluster, opportunities to processes along the value chains in agribusiness (Shogentsukova & Shogentsukov, 2020), competitiveness and innovation (Medennikov, 2020); manage threats faced by agribusiness easily using the strength of numbers (Bowen & Morris, 2019) and improve efficiency and sustainability of Agric-enterprises (Aleksandrov et al., 2021). Kosareva et al. (2019) avers that the use of big data analytics creates prospects for government intervention to SMEs for economic development and food sustainability.

IV. DISCUSSION

A key finding from this SLR is that digital agriculture for food sustainability is influenced by the digital innovation development in each country of study and based on digital technology advancement in such country. Thus far, the agribusiness digital transformation has not been able to keep pace with the fast-technological changes especially in the developing economy. This is due to the wide range of available digital technologies with different uses and functionalities. Researchers examining the effect of varieties of digital technologies for common use may create knowledge transfer as well as implementation challenges.

The second important result from this review regarding the digital agriculture processes indicates three most important stages namely acquisition, adoption and implementation, and the impact stage. The adoption and implementation stage have the highest focus in this field of study, while the least focus was acquisition or DA development stage. The evidence here means majority of the studies adopt an existing technology as a practical to understand the use of digital technology in agribusiness. Secondly, exploring the implementation stage requires an empirical research study (Bolfe et al., 2020; Bowen & Morris, 2019; Chung et al., 2021; Markovic et al., 2018; Prause et al., 2021; Yiyan et al., 2020; Zhou et al., 2017) which usually require data from the field. Also, few of the journal reviewed explore more than one stages of the digital agriculture process (Amirova et al., 2018; Bowen & Morris, 2019; Nitturkar, 2021; Ravis & Notkin, 2020; Saberioon et al., 2013; Small, 2017). There is need for more research to explore the acquisition stage and the impact stage of the process.

Agricultural business is noted to require a large amount of data to make an informed decision. Data on soil, temperature, rainfall, land, price, market and many others along each value chain. However, based on the review agro-industrial complex that expected to have access to many of these data is less research area thus creating a vacuum for research exploration in this aspect of entrepreneurship paradigm.

A. Theory

From reviewing theories used for digital agriculture research, conceptual studies are very few. This may hinder the progress in the digital agribusiness research. Most of the contributions are technologically driven as no theory underpinning the studies was employed. While others test the concepts of a borrowed model in the context of this study. The twenty theories underpinning studies in this review can be classified into two segments of ICT oriented and management oriented. ICT oriented theories include: object-orient theory (Yong et al., 2002), technological disruption (innovation) (Small, 2017), information entropy theory (Markovic et al., 2018), theory U (Santiago et al., 2018), theory of fictional expectations (Carolan, 2020) assemblage theory (Klerkx et al., 2019) digital democratization (Yiyan et al., 2020) and actor-network theory (Pauschinger & Klauser, 2021).

The management-oriented theory evaluates the interaction between human, society and digital technologies. Bowen & Morris (2019) examine the impact of digital agriculture in entrepreneurship and location effects theory. Others include complimentary theory (Medennikov, 2020), economic theory ((Birner et al., 2021; Shogentsukova & Shogentsukov, 2020) theory of human behaviors (Giles & Stead, 2021), corporate social responsibility (Ebrahimi et al., 2021) and social practice theory (Heidenstrøm & Hebrok, 2021) that explore the social angle of the digitalization of agribusiness technology. For future research there is need for wider approach to the development of digital agriculture theory.

B. Contextual Richness

Because the low-income economies are generally labour and agricultural oriented with little or inadequate capabilities to invest in digital technologies, this research advocate for more research on the status and prospects of transformation of physical agriculture into digital agriculture in these economies. This will contribute to the overall understanding of the impact of information and communication technology on the food sustainability for economic growth and development. This will also create opportunities to understand the difference and

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similarities in the workability of digital agriculture in agribusiness, not only in developing economies but across all economies, cross-continent comparative analysis is still almost non existing.

Nitturkar (2021) conducted a study that cut-across developing economies namely India, Nigeria and Kenya on the impact of implementation of digital agriculture by drawing on the previous failure in the use of technology in agribusiness. The author then develops a tool to validate the success of digital agriculture before implementation. A study by authors from different region in developed countries established a framework for successful digital transformation based on "social-cyber -physical system" (Rijswijk et al., 2021). However, this call for more research with focus on evaluating the digital agriculture transformation across all economies and impact on economic development.

C. Future Research

Our findings propose some avenue for future researcher in the field of digital agriculture. In areas of theory development, context and content. These areas are observed to be intertwined; however, we focus on the important research gaps as summarized in Table 6.

Table 6: Future research on digital agriculture.

Content	*The similarities and differences of digital technologies in agribusiness*
	The right combination of acquisition, implementation and impact stages of ICT in agriculture
	What moderating or mediating factors between digital agriculture and agribusiness performance.
	The connections between the acquisition, implementation and impact stages in relation to agribusiness.
Theory	*Development of new theory that enhanced the explanation of digital technologies in agriculture.*
	The business management theories that best explain the concept of digital agriculture.
	More empirical testing of the proposed conceptual framework.
	Combination of theories from different discipline to better explain digital agriculture.
Context	*The status and projections for the use of digital agriculture in less developed economies.*
	The development of digital technology in agribusiness across countries: comparative analysis
	To determine social, political and geographical influence on the development of digital agriculture.

V. CONCLUSION

The objective of this study was to identify scholarly articles and key contributions to the digital agriculture discussions. This systematic literature review has provided synopsis of the current movements in digital agriculture and its paradigms. We obtained and analyzed 67 journals from scientific databases and web search. The analysis revealed that majority of the articles did not use any theory, with qualitative methodology as most used approach. This study has identified Europe as the region with the highest number of articles, while least developed economies are not represented in the analysis. We attribute this to the cost associated to the transformation from traditional agriculture to digital agriculture. The concept of Internet of Thing dominated the discourse, followed by big data and artificial intelligence. The issue of privacy and security were not really addressed by the articles. This research presents the current discourse in a bid to pave way for understanding future exploration regarding digital agribusiness.

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This study makes contributions to the concept of digital agriculture in general and food sustainability. We have stressed that digital infrastructure in agribusiness need proper governance structure that will drive environmentally sustainable food security in agriculture production, processing, marketing and logistic systems. The findings in this study are relevant for all stakeholders in agribusiness, policy makers, technology makers and vendors. Farmers can use these findings to understand the benefits of moving from the old ways of farming by incorporating digital technology. Technology development company could demonstrate innovative capacity through continuously evolving in digital applications development for agribusiness.

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