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Research trends, theories and concepts on the utilization of digital platforms in agriculture: A scoping review

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Abstract. Globally, the agriculture sector is faced with multiple challenges especially in developing countries where smallholder farmers face barriers such as lack of access to financial services, information, formal and/or economic identity. The utilization of digital platforms in agriculture can offer solutions such as information services, financial inclusion and access to credit, digital identities, track and traceability systems, farm management systems and access to markets. This paper explores the research trends, theories and concepts associated with the utilization of digital platforms in agriculture. Using a scoping review and a directed content analysis approach, 52 papers were studied. It was found that studies have so far focused mainly on the policy, economics, knowledge and innovation systems, impact and adoption of digital agriculture platforms. The findings of this scoping review will aid in the understanding of the state of research on the utilization of digital platforms in agriculture and contribute to future research by helping to identify gaps in the relevant literature.

Keywords: Digital platform, Agriculture, Scoping review.

1 Introduction

The utilization of digital platforms in agriculture can provide solutions to challenges such as lack of information, credit, insurance and identity for farmers, especially in developing countries. It can also provide full and real-time visibility, assist in capturing and analyzing data for the management of value chain activities [1]. Digital Agriculture Platforms (DAPs) provide information services on agricultural extension, education, certification standards and skills for farmers. They also boost the ability of farmers to share knowledge and experiences [2]. They promote financial inclusion by granting smallholder farmers access to digital financial services which include credit, insurance [1, 3] and farm inputs [4, 5]. In addition, DAPs can serve as track and traceability [6], farm management and data management systems for value chain stakeholders [1, 2].

The aim of this study is to explore the utilisation of digital platforms in agriculture by conducting a scoping review of peer-review articles by (1) identifying the focus areas where studies on DAPs have concentrated, (2) theories and concepts that have been utilised in DAP studies and (3) trend of DAP research. The research questions

follow directly from the aim of this study. *The research questions are: (1) What focus areas have research on the DAP concentrated on? (2) What theories and concepts have been utilized in DAP research? (3) What has been the trend of DAP research based on focus areas and the number of studies?*

2 Methodology

This scoping review is based on the steps suggested by [7] in their seminal paper. These are 1. identifying the research question, 2. identifying relevant studies, 3. study selection and 4. charting the data and 5. collating, summarizing and reporting the results. Having identified the research questions in the previous section, steps 2 and 3 will be applied in this section and then steps 4 and 5 will be utilized when presenting the results of this study.

2.1 Identifying relevant studies

The search for **relevant** articles was done on 6 July 2020 using **Scopus**. The following search string was used to search for literature on the use of digital platforms in agriculture: ("agriculture" OR "farming" OR "horticulture") AND ("digital" OR "ICT" OR "mobile") AND ("Platform").

2.2 Study selection

There exists the engineering or technological view and the economic or transactional view in the discussion of platforms [8, 9]. There is also the information systems view with a socio-technical perspective [10]. Papers that *solely* discussed the design and development of platform architecture exclusively usually concentrated on the design of software and hardware systems. These were excluded. To meet the inclusion criteria, the paper must be a peer-reviewed journal article and must be published in English.

For the results of this scoping review to be useful, the study selection must be transparent, reproducible and adequately documented [11]. For this reason, the **Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)** was used as the guide for the selection of relevant literature [12]. Figure 1 shows the selection process based on PRISMA and adopted from [12]. The first screening involved examining the titles and abstracts and the second screening involved analyzing full-text.

2.3 Data Extraction and Charting of Included Studies

Using a directed content analysis approach which allows the researcher to validate or extend conceptually a theoretical framework [13], various categories of data pertinent to answering the research questions were identified and recorded. Using the thematic clusters identified by [14] in their review on digital agriculture, smart farming and agriculture 4.0 as the starting point, key concepts were identified as initial coding categories. The selected articles were then analysed, and the data extracted and categorized.

The following information was recorded in an Excel spreadsheet: Author(s), title, year, number of citations, country, geographical location, Methodology (eg. Literature review, case study, etc.), Methodology Classification (Empirical research, theoretical research or design and development), Theoretical or Analytical lens and target of observation (eg. Smallholders, value chain actors, etc.). Following the fourth step recommended in the methodology proposed by [7], the data were analysed and classified in a manner that allowed for charts to be produced to represent the information.

3 Results

This section presents the results from the study selection, the coding, analysis and categorisation of the identified studies included in the scoping review.

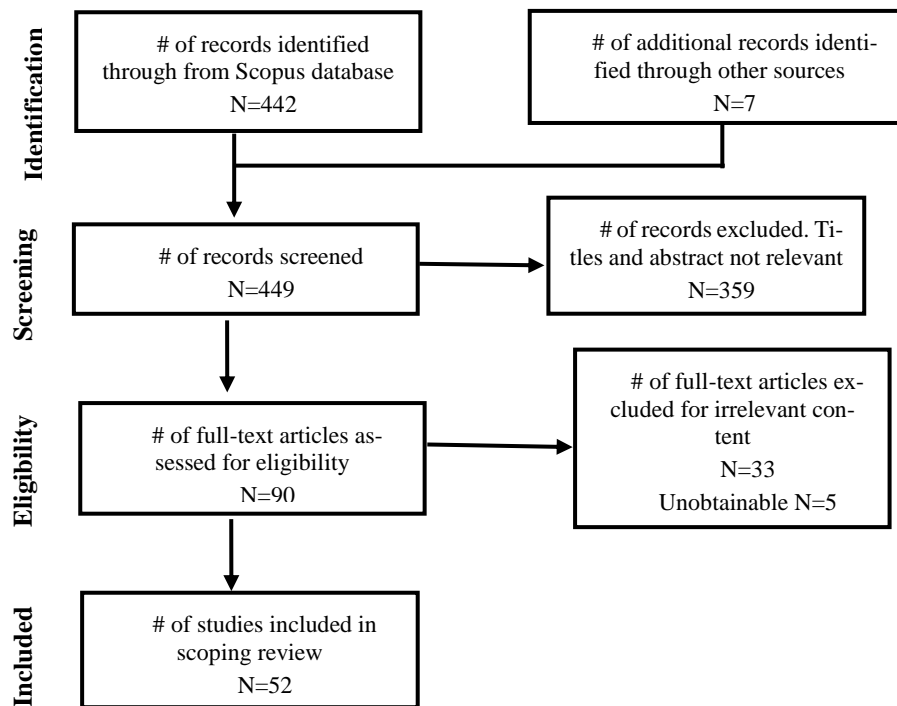


Figure 1: PRISMA flow diagram showing study selection

3.1 Identification of Included Articles

As represented in figure 1 above, the search from Scopus produced 442 results. Seven additional articles were added. This means a total of 449 articles were screened as part of the study. Of the 449 articles, 359 articles were excluded based on examination of

titles and abstracts. Thereafter 90 articles were studied, and the full texts were assessed for their relevance to DAPs. 38 were excluded during the full-text assessment because 33 were found to have focused on the design and development of software and/or hardware used in Smart Farming, Precision Agriculture and Agriculture 4.0 while five articles were inaccessible. After the study selection, 52 articles were identified as relevant.

3.2 Collating, Summarizing and Reporting the Results

In this section, the results from the coding, analysis and categorization of the selected articles are discussed to answer the research questions specified in Section 1 above.

Characteristics of Included Articles. The percentage distribution of the articles per geographical location is as shown in Figure 2. None of the selected papers focused explicitly on Central Asia and the Middle East and North Africa. ‘Global’ represents studies that are not localised to any geographical location.

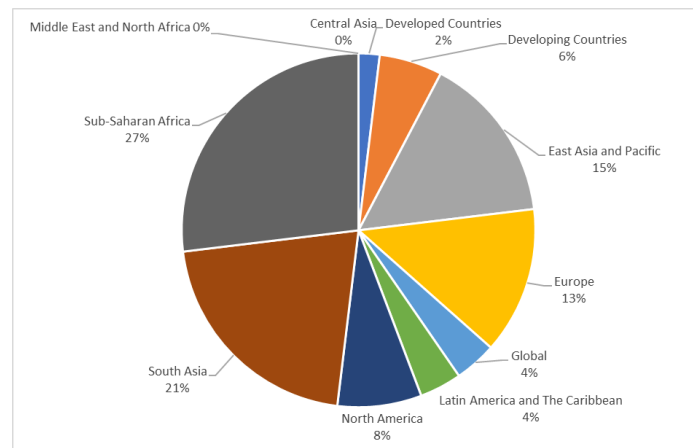


Figure 2: Geographical Location of the Included Articles

Categorizing Included Articles into Themes. Using the thematic clusters identified by [14] as the starting point, the articles included in the study were categorized into five thematic areas as shown in Table 1. They are:

- Thematic Area 1: Economics and management of DAPs in agriculture.
- Thematic Area 2: Agricultural knowledge Systems, Innovation Systems and Innovation Ecosystems.
- Thematic Area 3: Impact of DAP.
- Thematic Area 4: Adoption, use and adaption of DAPs.
- Thematic Area 5: DAPs from the Policy/Politics/Governance/Perspective.

It must, however, be stated that some studies covered more than one thematic area.

Table 1: Categorization of included articles based on thematic areas

Economics and management of DAPs in agriculture value chains	Business Models	Access based business model /Sharing economy	[15]
	Production Management	Cost Analysis and Management	[16], [17]
		Farm Management System	[18]
		Track and traceability systems	[6]
	Financial Sustainability	Profitability of providing digital platforms with infrastructure.	[19]
	E-Business	Effect of digital platforms on commodity prices	[20]
		Connection of value chain actors	[3], [18], [21], [22], [23], [24]
Market Structure	Creation of an alternative market structure	[19], [47]	
Digital Platforms and agricultural knowledge and innovation (Eco)systems	Knowledge Systems	Technology Transfer pathways	[25]
		Agriculture Extension Services	[26], [60]
		Knowledge sharing, co-creation and management	[27], [28], [29], [30], [31], [32], [33], [34], [35]
		Decision Support Systems	[36], [37]
	Ecosystems	Knowledge Services	[38]
		Urban Food Ecosystem	[39]
	Innovation Systems	Innovation Intermediation	[40]
Digitalisation of Agriculture Innovation Systems		[41]	
Impact of DAP	Farmers' Work Routine		[42]
	Lock-in tendencies		[43]
	Enabling efficiencies through information sharing		[16], [19]
	Collective and Individual learning and training		[27], [44], [45]
	Early warning system for flood management		[46]
	Access to farm mechanization by smallholder farmers		[15]
	Trust mediation for Value Chain Financing		[5]
	Uses and Opportunities		[47], [48]
	Benefits		[2], [32], [33], [47], [49], [50]
	Land Use and Gentrification		[51], [52]
	Effect on Foodscapes		[53]
Productivity		[4], [50], [54]	

Adoption, use and adaptation of Digital Agriculture Platforms	How Digital Agriculture Platforms encountered		[53]
	Inclusive Value Chain Partnerships		[55]
	Information sharing and education		[30], [36], [61]
	Challenges and Limitations		[2], [3], [18], [44], [47], [48], [56]
	Determinants and moderating factors influencing value		[35]
	Necessity and Feasibility		[56]
	Adoption of digital platforms among smallholders		[57]
	Monitoring Carbon stocks on smallholder farms		[58]
	Determinants and moderating factors of user acceptance and usage behavior		[16]
DAP from the Policy/Politics/Governance/Performance/Perspective	Power, ownership, privacy, ethics and politics of Digital Agriculture Platforms	Distributive politics of Digital Agriculture Platforms	[42]
		Effect of ownership structure and governance	[43], [53]
		Data privacy and ownership	[41]
	Public Administration	Food Safety and Regulation	[6]

The impact of DAP on agriculture has been studied the most. The studies concentrated mainly on the benefits and opportunities offered by DAP especially to smallholder farmers. The least studied area has been the policy perspective of DAP. The few studies reviewed focused on ownership structure, data privacy and regulation, especially in developed countries. No research in this thematic area focused on Sub-Saharan Africa.

Methodology, Theoretical and Conceptual Perspectives of the Included Articles.

Three of the selected articles dedicated their methodology section to a discussion of the design and development of DAPs. Of the remaining 49 articles, 43 (88%) were empirical research and six (12%) were theoretical research. The six theoretical research articles were made up of four papers focused on reviews and two dedicated to models on DAPs.

The theoretical and conceptual perspectives of the articles were also identified as shown in Table 2. While some studies focused on one theoretical perspective, others looked at the studies using multiple lenses. Value Chain theory was applied the most.

Table 2: Theoretical and Conceptual Perspective of Reviewed Articles

Theoretical and Conceptual Perspective	Articles Reviewed
Business Model: Access-based business model	[15]
Diffusion of Innovation Theory	[26], [61]

Assemblage Theory	[52], [53]
Competence Model	[45]
Contingent Effectiveness Model of Technology Transfer	[25]
Critical Theory (Critical Data Studies)	[52]
Cross-platform Mobile Development Framework	[48]
Decision Support Systems	[46], [51]
Design Patterns and Storytelling	[31]
Digital Native, Digital Immigrants concept	[32]
Economic Theory: Bargaining power, Information Asymmetry and Structural Differences	[20]
Productivity	[50]
Two-sided Market	[23]
Econometric Analysis	[59]
Ecosystem: Innovation Ecosystem	[38], [39], [41]
Innovation	[2], [58], [60]
Information Systems Concept:	
Information Chain	[29]
Technology Acceptance Model	[26]
Innovation Systems	[40]
Interconnected Systems	[33]
Knowledge Systems	[36]
Marketing Concept	[18]
Multi-criteria Decision Analysis	[37]
Multi-criteria Evaluation	[30]
Networked Community	[54]
Operational Model	[24]
Pedagogical Model	[44]
Propensity Score Matching (PSM) Approach	[4]
Requirements Analysis	[56]
Responsible Research and Innovation	[27], [41]
Skills, Community Development, and Structural Inequalities perspective	[42]
Sociomaterial Perspective	[3]
Sustainability	[19]
Sociological underpinnings of 'the' future, political ontology and Foucault's Concept of Dispositif	[43]
Total Quality Management: Quality Function Deployment	[17]
Transition Theory: Multi-level Perspective (MLP)	[41]
Unified Theory of Acceptance and Use of Technology Model	[16]
Use Case Model	[28]
User-centred Design	[49]
Value Chain	[5], [6], [21], [22], [55], [57]
Vibrant materialism, Geographies of care, enactive politics	[53]

Trend of Digital Agriculture Platform Studies. Figure 3 presents the number of articles in the five thematic areas published over time. Research on the utilization of

digital platforms in Agriculture has been published since 2004. However, it was in 2017 that the number of articles for all thematic areas started increasing. Over the year, the most consistent thematic area that has been researched is the impact of DAP. Until 2016, not all thematic areas were researched every year but since 2017, every thematic area has seen an increase in the number of studies.

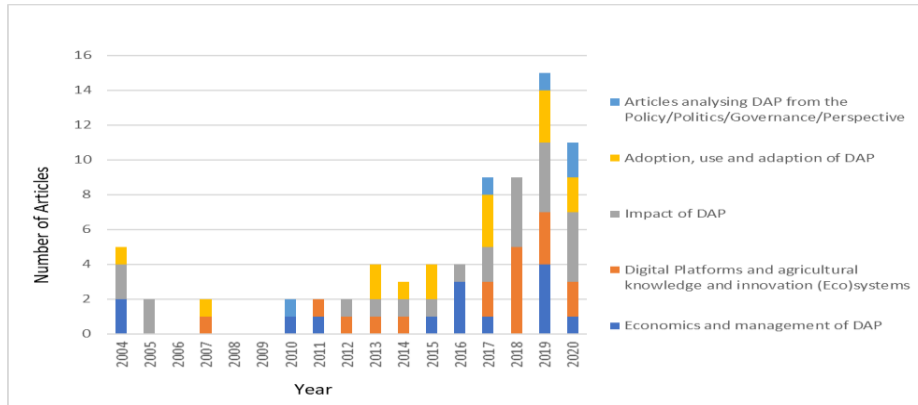


Figure 3: Number of articles per thematic area published over time

4 Discussion

No article focused explicitly on Central Asia and the Middle East and North Africa. This indicates a gap in DAP literature for these parts of the world. Most of the articles on Sub-Saharan Africa, South and East Asia also focused mainly on smallholder and rural farmers. Conversely, most of the articles that concentrated on developed countries concentrated on the entire value chain.

Articles on the “Economics and Management of DAPs in agriculture” discussed the benefits of DAPs from the economic or farm management perspective. The benefits include creating a digital marketplace [3, 9, 21 - 24], new business models such as access-based business models or sharing economy [15] and the creation of alternative market structures [19, 47]. DAPs can also assist with farm operations [18], cost management [16, 17] and quality assurance [6].

Most of the articles reviewed on “Agricultural knowledge Systems, Innovation Systems and Ecosystems” discussed the use of DAPs to share knowledge and information [27-35]. Specifically, [26] and [60] explored the use of mobile telephony to support agricultural extension services for rural farmers. [25] focused on technology transfer after donor projects have been completed.

A significant number of the articles reviewed discussed the impact of DAP on farming, farmers and value chain actors. These articles studied the use of DAPs for enabling efficiencies through information sharing, collective and individual learning and training, early warning systems for flood management, access to farm mechanization by smallholder farmers, trust mediation for Value Chain Financing and improved land management and productivity.

Only five of the 52 articles discussed DAPs from the policy or governance perspective. This is the least number of articles selected from any thematic area. The articles surveyed are dominated by empirical research. Of the six theoretical papers, four were reviews and two focused on models related to DAPs. There was no scoping review among the selected articles. DAPs are been studied using a wide range of theoretical and conceptual lenses. The value chain concept has been used in a significant number of studies from Sub-Saharan Africa [5, 6, 21, 22, 55, 57].

From the scoping review, research on DAPs is started quite recently. The first articles from the included studies were published in 2004. These early articles studied the impact, adoption, use and adaption of DAPs and the Economics and management of DAPs. However, in 2017 research on DAPs almost doubled and has been increasing in recent times with articles covering agricultural knowledge systems, innovation systems and innovation ecosystems and policy in addition to the thematic areas mentioned above. In recent times, more articles have also targeted developing countries.

4.1 Strengths and Limitations of this Scoping Review

PRISMA guided the selection of relevant literature so that the study selection will be transparent, reproducible and adequately documented. However, some relevant studies may have been omitted. This scoping review identified and selected English articles from the Scopus Database. While the articles in Scopus are usually peer-reviewed and the journals are generally of high academic and intellectual value, knowledge of DAPs is not limited to Scopus. Also, reviewing only peer-reviewed journal articles means that knowledge in grey literature may have been overlooked.

5 Conclusions, Implications and Directions for Future Research

Research on DAPs is quite recent. They started in 2004. Since 2017, the number of studies on DAPs has increased significantly.

This study reveals the need for studies that address the systemic challenges confronting the development of DAPs and the corresponding systemic policy frameworks required to tackle them. Also, the lack of research from the policy and innovation systems perspective in Sub-Saharan Africa context must be addressed. Specifically, rigorous studies are required to address topics such as data privacy and protection, data governance and the regulation of DAPs. By mapping and categorising the literature on DAPs, researchers and policymakers will be able to address the issues related specifically to each theme that was identified.

It also provides different routes for future research on DAPs by categorising the included studies into themes and highlighting the research that has already been conducted under each theme. The lack of literature from Central Asia and the Middle East and North Africa is proof that studies on DAPs published in English are needed from these geographical areas. Finally, it is suggested that since this scoping review used only literature from SCOPUS, a similar review is conducted that covers several

recognised databases. This, it is believed, will assist in providing a more holistic picture of the research about DAPs.

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