

AGRICULTURAL RESEARCH IN SUDAN

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ABSTRACT

The primary sector continues to hold a significant socio-economic importance in Sudan. The country faces numerous challenges, including food insecurity, which are intensified by ongoing conflicts and instability. There is a need for research to promote the transformation of the agri-food system to tackle these challenges. Nevertheless, a thorough examination of the country's research landscape is absent. Consequently, this review presents a bibliometric analysis of academic literature pertaining to agriculture in Sudan. It is based on a systematic review of 163 eligible articles obtained through a search performed in March 2025 on the Web of Science. The analysis highlights several shortcomings within the research field, including a low annual output of publications, a dominant focus on biological and environmental sciences, and nearly half of the articles that concentrate on Sudan failing to include any Sudanese scholars. Furthermore, many prominent organizations in the research field are based outside of Sudan. Notable Sudanese institutions comprise the University of Khartoum, the Agricultural Research Corporation (ARC), the University of Gezira, and the University of Gadarif. The research field primarily focuses on crop production and the production phase of the food supply chain. Despite a notable increase in the number of publications over recent decades, indicating a growing interest in agricultural research in Sudan, this progress was regrettably interrupted by the war. Investment in research is crucial to make the agriculture sector an engine for growth and development during the postwar recovery in Sudan.

Keywords: *Agronomy, Bibliometrics, Food, North Africa, Sahel.*

INTRODUCTION

Sudan is a large country situated in Northeast Africa. It spans across the Red Sea and is divided from south to north by the Nile River, which is formed by the merging of the White and Blue Niles in its capital, Khartoum. The country has a varied

landscape, ranging from deserts in the north to semi-arid and semi-desert areas in the south, with fertile regions along the Nile valleys. Agriculture plays a crucial role in Sudan's economy, accounting for a significant portion of its Gross Domestic Product (GDP), approximately one-third in 2022, and employing more than half of the population, especially in rural areas (FAO, 2025; World Economic Forum, 2024). This sector is also a key source of foreign exchange revenues. It is generally categorized into rain-fed agriculture, primarily found in the southern and western regions, and irrigated agriculture, which depends heavily on the Nile River and its tributaries, particularly in the Gezira Scheme, recognized as one of Africa's largest irrigated agriculture initiatives (Sudanese Embassy in Ankara, 2025).

Sudan has considerable potential in terms of crop production; it is viewed as a possible 'breadbasket' for the area. The nation cultivates a variety of crops, including staple grains like sorghum, millet, wheat, maize, and rice (World Economic Forum, 2024). Cash crops are essential for its exports, with Sudan being a major global producer and exporter of oily seeds like groundnuts and sesame, as well as being the leading producer of gum Arabic, harvested from Acacia trees (OECD, 2023; World Economic Forum, 2024). Other important crops include cotton and sugarcane. Animal husbandry is also vital in Sudan's agricultural sector. The country supports a significant livestock population, estimated at over 110 million animals, including cattle, camels, sheep, and goats (World Economic Forum, 2024). Livestock exports, chiefly to Saudi Arabia, other Gulf States, and Egypt, have gained importance, competing with cash crops as a rapidly growing non-oil export sector (FAO, 2025). Although the fishing industry is relatively underdeveloped, Sudan holds high potential, particularly due to its Nile rivers and the Red Sea. The Nile serves as a crucial source of fish, primarily Nile perch, which is mostly consumed locally. Additionally, the Red Sea provides large amounts of fish and shellfish (Encyclopaedia Britannica, 2025). In spite of obstacles like climate change and inadequate infrastructure, Sudan's rich natural resources and strategic location present significant opportunities for agricultural development and investment (Sudanese Embassy in Ankara, 2025).

Agricultural research in Sudan, before the recent conflict, aimed at increasing productivity in both rain-fed and irrigated farming sectors, enhancing staple crops (e.g., sorghum, millet, and wheat), as well as developing cash crops including groundnuts, sesame, and gum Arabic (World Economic Forum, 2024). The ongoing war, which began in April 2023, has significantly affected agricultural research and the overall food system. The conflict has greatly disrupted agricultural research efforts due to the direct destruction of facilities, the displacement of both researchers and farmers, and widespread insecurity (Mercy Corps, 2024). Research centers, typically situated near urban areas or key strategic points, have been particularly vulnerable to looting and damage (Hoffmann, 2024). This situation has led to a sharp decline in crop production, raising the threat of an impending famine and complicating efforts to tackle persistent issues like climate change and food insecurity (FAO, 2024).

Research can play a vital role in advancing the agricultural sector of Sudan and reshaping the nation's food system. Nevertheless, there is a lack of an up-to-date assessment of the research landscape in Sudan. In this regard, the current review offers a bibliometric analysis of academic literature related to agriculture in Sudan.

METHODS

This article draws upon a comprehensive review of all documents catalogued in the Web of Science (WoS) Core Collection and complies with the PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Moher et al., 2009; Page et al., 2021). In March 2025, a search was performed using the following query: (*agriculture OR agro OR agri*) AND *Sudan*. Consequently, a limitation of the study is that publications referencing East Africa, North Africa, or the Sahel without mentioning Sudan might not have been captured in the search. To qualify for inclusion in the review, documents needed to satisfy three eligibility requirements: they had to be geographically pertinent (i.e., they must focus on Sudan), thematically relevant (i.e., they should pertain to research on agriculture), and of a specified document type (i.e., only journal articles, book chapters, or conference papers were considered; materials like letters to the editor, commentaries, notes, and reviews were excluded). Only those documents fulfilling all three criteria were considered eligible and included in the review.

The search performed on WoS yielded 462 documents (Table 1). However, during the preliminary screening, 131 documents were eliminated based on their titles since they were not relevant to Sudan. Articles or documents that discussed a wider geographical region, such as the Sahel, East Africa, North Africa, sub-Saharan Africa, the Arab World, the Horn of Africa, the Nile Basin, or those that did not clearly define the geographical scope in their titles, were retained for further examination. Meanwhile, documents referring exclusively to West Africa were excluded. After reviewing the abstracts, an additional 136 documents were removed as they did not satisfy at least one of the inclusion/eligibility criteria. In particular, documents clearly referring to South Sudan were excluded. Conversely, documents referring to specific areas of Sudan – such as Khartoum, Darfur, Kordofan, Gedaref/Gadarif state, Kassala state, Red Sea state, Gezira scheme, New Halfa Agricultural Scheme – were considered eligible. Many documents refer to the Sudanian, Sudano-Sahelian climate, but not to Sudan. Further documents refer to Sudan grass or Sudan black, a colorant. Finally, the evaluation of full texts resulted in the exclusion of 30 documents, which included 13 reviews. Consequently, the systematic review comprised 163 documents (151 articles and 12 proceedings papers).

Table 1. Selection of eligible documents dealing with research on agriculture to be included in the review.

Selection steps	Number of potentially eligible documents	Number of excluded documents and exclusion reasons
Search on WoS	462	No duplicates
Screening of documents based on titles	462	131 documents were excluded because they deal with countries other than Sudan, e.g., Benin, Burkina Faso, Cameroon, Egypt, Ethiopia, Ghana, Jordan, Kazakhstan, Kenya, Libya, Niger, Nigeria, Pakistan, Saudi Arabia, Senegal, South Sudan, Uganda, and Yemen
Screening of documents based on abstracts	329	136 documents excluded: <ul style="list-style-type: none"> • 72 documents that do not deal with Sudan • 63 documents that do not address research on agriculture • 1 document without an abstract
Scrutiny of full-texts	193	30 documents excluded: <ul style="list-style-type: none"> • 15 documents that do not deal with Sudan • 2 documents that do not address research on agriculture • 13 reviews
Confirmation of eligibility and inclusion in the systematic review	163	--

The selected articles underwent a bibliometric analysis focusing on journals (cf. sources, publication titles), research domains/areas, Sustainable Development Goals (SDGs), authors, their affiliation organizations, and their countries of affiliation, and financing bodies. Furthermore, analyses were conducted on agricultural subsectors (cf. crop production and the main crops discussed, livestock production, and fisheries/aquaculture) as well as stages of the food chain (namely production, processing, distribution/retail/marketing, and consumption). All evaluations were conducted using the methodology described in the study by El Bilali and Ben Hassen (2023).

RESULTS AND DISCUSSION

Based on the evaluation of the selected documents, it can be concluded that the first article concerning agri-food in Sudan, indexed in WoS, was published in 1991 (Abdelmageed et al., 1991).

The *annual production of articles* shows significant fluctuations, but overall remains relatively low. The number of published articles was just one article in some years (e.g., 2001, 2002, 2003) and reached a peak of 17 in 2023. Indeed, there has been an overall increase in the number of publications, indicating a growing interest in agricultural research in Sudan. The number of annual publications ranged between one and five in the period from 2000 to 2010. It was equal to or above five in the period between 2011 and 2020. The highest numbers of publications were recorded in 2022 (13 articles) and 2023 (17 articles). This suggests an increasing trend in the number of publications. However, the number of publications dropped significantly in 2024, from 17 in 2023 to just 9 in 2024; this might be due to the war in the country. In terms of *sources* (Table 2), the largest number of articles was published in Land Degradation Development and Land Use Policy (5 articles each), followed by AMA Agricultural Mechanization in Asia, Africa, and Latin America (4 articles). Nonetheless, there was a total of 133 journals and sources that published research on agriculture in Sudan, indicating that there are no dedicated publication outlets.

Among the chosen articles, the largest number corresponds to the *research areas* of Agriculture (49 articles, 30.06%), followed closely by Environmental Sciences – Ecology (48 articles, 29.45%), then Water Resources (22 articles, 13.50%) (Table 2). The 163 selected documents can be categorized into 37 distinct research areas (e.g., anthropology, archaeology, biodiversity conservation, biotechnology – applied microbiology, business economics, chemistry, development studies, engineering, entomology, food science technology, geography, geology, imaging science – photographic technology, meteorology – atmospheric sciences, nutrition dietetics, plant sciences, science technology and veterinary sciences), indicating that agricultural research in Sudan encompasses multiple disciplines. However, it can be contended that while there is sufficient coverage of environmental and biological sciences (cf. agriculture, environmental sciences – ecology), social sciences and economics tend to be neglected.

The diverse sectors and fields engaged in research are represented by the *Sustainable Development Goals* (SDGs) that are addressed (Table 2). Sixteen SDGs are connected to the chosen articles, with the most significant being SDG 13 – Climate action (94 documents, 57.67%), SDG 15 – Life on land (75 documents, 46.01%), SDG 02 – Zero hunger (63 documents, 38.65%), SDG 14 – Life below water (52 documents, 31.90%), SDG 06 – Clean water and sanitation (40 documents, 24.54%), SDG 11 – Sustainable cities and communities (31 documents, 19.02%) and SDG 03 – Good health and well-being (29 documents, 17.79%). Furthermore, less prominent SDGs include SDG 01 – No poverty (13 documents), SDG 12 – Responsible Consumption and Production (5 documents), SDG 08 – Decent work and economic growth (4 documents), SDG 10 – Reduced inequalities (4 documents), SDG 05 – Gender equality (3 documents), SDG 17 – Partnerships for the Goals (3 documents),

SDG 09 – Industry, innovation, and infrastructure (3 documents), SDG 07 – Affordable and clean energy (3 documents), and SDG 16 – Peace, justice, and strong institutions (2 documents). A single document may correspond to one or multiple SDGs.

The examination of the chosen publications reveals that Nadir Ahmed Elagib (7 articles – University of Cologne, Germany), Hussein M. Sulieman (5 articles – University of Gadarif, Sudan), Andreas Buerkert (4 articles – University of Kassel, Germany), and Jens Gebauer (4 articles – Rhine-Waal University of Applied Sciences, Germany) stand out as the most significant and prolific *authors* (Table 2) in the area of agricultural research in Sudan. However, the 163 documents analyzed have been written by a total of 552 researchers, indicating that 548 of these scholars have produced only three or fewer articles. This observation indicates a lack of continuity within the research domain. In other words, it appears that even those investigating agriculture in Sudan do so in an irregular manner rather than in a systematic way. This, in turn, could be attributed to the absence of long-term research initiatives or programs in Sudan.

The examination of affiliation *countries* (Table 2) indicates that Sudan leads the research field with 70 publications, which represents 42.94% of the overall total. Nonetheless, this also implies that more than half of the chosen papers (*viz.*, 57.06%) concerning Sudan lack the involvement of local researchers. This observation, in turn, suggests that there may be certain weaknesses within the research landscape in the country. Apart from Sudan, the key countries of affiliation predominantly include those in Europe (e.g. England, Germany, Italy, Netherlands, Sweden), North America (e.g. USA), Africa (e.g. Kenya, Egypt), and Asia (e.g. China, Saudi Arabia, India, Japan).

The 163 documents chosen for review have been authored by researchers and academics linked to 305 *institutions* (Table 2), with a large share located outside of Sudan and even Africa. The leading Sudanese organizations engaged in agricultural research in Sudan include the University of Khartoum, the Agricultural Research Corporation (ARC), the University of Gezira, and the University of Gadarif. Numerous prominent organizations involved in research are situated outside of Sudan, primarily in Africa (e.g., Egyptian Knowledge Bank, EKB) and Europe (e.g., Technical University of Dresden – Germany, University of Kassel – Germany, IHE Delft Institute for Water Education – the Netherlands). Notable institutions also comprise various international organizations like CGIAR (Consultative Group for International Agricultural Research) and the Food and Agriculture Organization of the United Nations (FAO). These results indicate a collaborative network of researchers focusing on agriculture in Sudan from various countries and organizations, but they may also highlight a deficiency in the nation’s agricultural knowledge and innovation system (AKIS).

Table 2. Bibliometrics of the scholarly literature on agricultural research in Sudan: top ten items.

Journals/sources (a*)	Research areas (b*)	SDGs (c*)	Authors (d*)	Countries (e*)	Organizations (f*)
Land Degradation Development (5)	Agriculture (49)	SDG 13 – Climate action (94)	Elagib N A (7)	Sudan (70)	University of Khartoum (22)
Land Use Policy (5)	Environmental sciences – Ecology (48)	SDG 15 – Life on land (75)	Sulieman HM (5)	USA (27)	Agricultural Research Corporation (10)
AMA Agricultural Mechanization in Asia, Africa and Latin America (4)	Water resources (22)	SDG 02 – Zero Hunger (63)	Buerkert A (4)	England (26)	CGIAR (10)
Food Security (3)	Science technology (15)	SDG 14 – Life below water (52)	Gebauer J (4)	Germany (25)	University of Gezira (10)
International Journal of Remote Sensing (3)	Business economics (14)	SDG 06 – Clean Water and sanitation (40)	Eltahir EAB (3)	China (15)	Egyptian Knowledge Bank (8)
PLOS One (3)	Geology (13)	SDG 11 – Sustainable cities and communities (31)	Makki EK (3)	Kenya (12)	FAO (7)
Remote Sensing (3)	Engineering (11)	SDG 03 – Good health and well being (29)	Tada A (3)	Italy (11)	University of Gadarif (6)
	Remote sensing (10)	SDG 01 – No Poverty (13)	Tanakamaru H (3)	Netherlands (11)	IHE Delft Institute for Water Education (4)
	Meteorology – Atmospheric sciences (8)	SDG 12 – Responsible consumption and production (5)	Tonnang HEZ (3)	Egypt (10)	Technical University of Dresden (4)
	Food science technology, Imaging science – Photographic technology, Plant sciences (7)	SDG 08 – Decent work and economic growth (4)		Saudi Arabia (9)	University of Kassel (4)

* Figures in parentheses indicate the number of documents/publications by a journal (a), a research area (b), an SDG (c), an author (d), an affiliation country (e), or an affiliation organization (f).

Research included in the 163 selected publications has been financed by 120 *funding agencies*. This suggests a diversity of funding sources but also the fragmentation of funding. The analysis indicates that the key funding organizations consist of the *Deutscher Akademischer Austausch Dienst* (DAAD – Germany), the European

Union, and the National Natural Science Foundation of China (NSFC). This implies that a substantial amount of financial support for research on agri-food in Sudan is sourced from abroad. Consequently, this underscores the deficiency of local funding, which presents a risk and may hinder the sustainability of domestic research initiatives.

A number of selected articles that address agriculture in Sudan do not identify a specific *agricultural subsector*. This is especially evident in studies that concentrate on food security, dietary habits, consumption trends, and livelihoods. Likewise, research that examines the repercussions of climate change and land use change typically fails to mention a particular subsector. When articles do focus on a specific subsector, they tend to concentrate on crop production, while studies on animal husbandry (Abdelmageed et al., 1991; Ali et al., 2023; Salim et al., 2021) and, particularly, fisheries are frequently neglected. Many articles discussing *crop production* examine topics like fertilization (Elsafy et al., 2024), water scarcity (Elagib et al., 2024), pest management (Castle, 1999), and irrigation (Babker et al., 2020). They also touch upon alternative agricultural practices, such as agroforestry (Fadl & Gebauer, 2005; Jamal & Huntsinger, 1993). The literature on crop production evaluates a range of *crops*, including millet (Fadl & Gebauer, 2005), sorghum (Elsafy et al., 2024; Khan et al., 2021), groundnut (Fadl & Gebauer, 2005), wheat (Khan et al., 2021), maize (Tonnang et al., 2018), sesame (Fadl & Gebauer, 2005), soybean (Ngalamu et al., 2023), and cotton (Abdalla et al., 2018; Khan et al., 2021). Most of the research emphasizes staple crops and cereals, alongside a select few export or cash crops such as cotton. A distinct feature of Sudan's scientific literature, with respect to other countries such as Mauritania (El Bilali & Ben Hassen, 2023), is its emphasis on irrigation and irrigated crops within schemes like Gezira (Abdalla et al., 2018; Khalifa et al., 2020). The emphasis in the *food chain* primarily lies on the production phase; however, some studies examine marketing and distribution (Bagnied & Speece, 2019; van der Waal et al., 2016), as well as consumption (Abdalla, 2024). In contrast, processing appears to be neglected in the current literature.

CONCLUSIONS

This article offers a detailed summary of agricultural research in Sudan through a bibliometric analysis of the field. The findings indicate that the annual output of publications fluctuates notably but is generally low. An increase in the number of publications suggests that interest in agricultural research in Sudan is growing, but such an increasing trend was dramatically affected by the recent war. The diversity of research areas and SDGs being addressed imply that agricultural research in Sudan spans multiple disciplines. However, the heavy focus on environmental sciences, at the expense of social sciences and economics, highlights the need for a more comprehensive approach to investigating agri-food systems in the nation. The fact that most authors have only published a limited number of articles could

reflect inconsistency within the research domain. The examination of affiliated countries reveals that around half of the papers selected, although focused on Sudan, do not include any contributions from Sudanese scholars or authors. This might point to weaknesses in the domestic research landscape. Numerous influential organizations in the research area are located outside of Sudan. This finding may further signal the fragility of the Sudanese Agricultural Knowledge and Innovation System (AKIS). Noteworthy Sudanese institutions include the University of Khartoum, the Agricultural Research Corporation (ARC), the University of Gezira, and the University of Gadarif. The existing literature predominantly focuses on crop production within agricultural subsectors. The research pertaining to crop production primarily centers around staple crops and cereals. The production stage of the food chain is the most frequently addressed. Supporting agricultural research in Sudan is essential to address challenges such as food insecurity, poverty, and climate change. This effort will facilitate the creation of a sustainable and resilient agri-food system. Additionally, research in this area is vital for unlocking the potential of the agri-food sector and transforming it into a significant driver of inclusive growth and sustainable development in Sudan. Investing in research is key to positioning the agriculture sector as a catalyst for growth and development in the postwar recovery phase in Sudan.

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