

Review

# Perception and Adaptation Strategies of Smallholder Farmers to Drought Risk: A Scientometric Analysis

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**Abstract:** Droughts are a worldwide issue that affects ecosystems' economies and cultures; therefore, its perception and adaptation strategies among smallholder farmers are crucial for the mitigation of drought risk, and for sustainable food production. We used the bibliometric method to analyze 121 publications from the Scopus database to better understand the existing situation and trends in the field of drought risk. During the years under consideration, the field saw a significant increase in publication output, with an annual growth rate of roughly 68.14 percent. On a national level, the United States scored first with the most publications and the most academic influence, with the majority of top papers citations coming from USA-connected universities and research centers. The top five most frequently used keywords and keyword-plus were, drought, adaptation, agriculture, smallholder farmers, and climate change. Some of the adaptation strategies adopted by smallholder farmers, which could be used by many nations to deal with drought events, include: rainwater harvesting, diversification of income sources, planting of short-season cash crops to enhance cash flow, use of drought-tolerance herds, etc. This research offers a plan to navigate the intellectual dilemma in drought risk research and offers guidance for researchers in all continents, particularly the Africans and the Europeans, in further studies in this area, as the agricultural sector contributes significantly to the economy of many nations.

**Keywords:** drought risk; adaptation; perception; smallholder farmers



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## 1. Introduction

As the global mean surface temperature continues to rise, more evidence has emerged indicating that societal, innate structure, and ecological systems are severely impacted by climate change [1]. Climate variability and change have significant impact on both developed and developing nations with greater impacts in the developing nations [2,3]. Climate change is forecasted to expand the occurrence, strength, and extent of droughts with an adverse consequence on the hinterland, particularly in Sub-Saharan Africa where societies basically rely upon rain-fed crop farming [4].

Drought disaster is so serious that it can cause the ascent and fall of a nation [5]. The well-known drought of Sahel Africa in 1975, Soviet Union in 1922, China in 1907, and India in 1967 were among the top universal climate, water, and environmental incidents of the twentieth century. As the worst natural disasters, they killed millions of people and put millions more on the verge of hunger [5]. Throughout the world, drought is ranked first among all the natural hazards accounting for about 5% of natural disaster and about 30% of losses of all casualties that come from disaster [6]. Droughts have various distinct characteristics when compared to other natural calamities. To begin with, defining its beginning and end is quite tough. Furthermore, drought progress is gradual and lasts for a prolonged period of time. Drought is a natural hazard that can have severe economic,

social, and environmental effects. It is the absence of rainfall over a long time, typically a season or more [7].

Smallholder farmers have been affected by drought impacts for several years [8]. Smallholder farmers suffer even more because they rely on agriculture for their living, making them the most susceptible when drought occurs [9]. Moreover, they have fewer resources to adapt compared to commercial farmers (medium- and large-scale farmers). It is obvious that the effects of changing climate such as drought will result in significant economic losses, particularly for smallholders whose primary source of income comes from agriculture. If economic losses to this susceptible group in society are to be prevented, countries must mitigate the anticipated negative effects of climate change [10]. Unarguably because of climate irregularities, smallholder farmers will continue to record losses upon losses as a result of production costs far outweighing the revenue they generate from their production [11]. Currently, there are about 500 million smallholder farms on this planet, and they contribute to about 60% of the World's agricultural production and produce up to 80% of food in developing countries [12]. Smallholder farmers are those whose farming area is less than or equal to 2 hectares of land, with inadequate wealth, and rely entirely on household labour [13,14]. The process of adapting to a drought consists of two phases: the first entails rural residents' perceptions of rising drought risk, while the latter covers a variety of adaptation measures that can lower that risk [15].

The perception of drought varies from place to place due to the interaction of natural drought and diverse human factors [16]. Farmers' perceptions of the impact of drought refer to a set of behaviors, beliefs, and judgments about droughts that are formed as a result of expectations, definitions, memories, experiences of, and exposure to drought [15]. Drought perception can help to ensure that drought adaptation strategies are implemented successfully [17]. Comprehending the people's sensitivity to droughts their impacts, and their perceptions of how droughts affect them, has the ability to help define that which can be done, and by who, who benefits from it, and how will it be assessed [18]. A reduction in the prices of livestock, production losses in livestock with mortality, poor health, rising food prices, crop failure, and drying of water resources are the most instantaneous effects of drought perceived by farmers [16,19]. The extent of farmers' perceptions and consciousness of drought, the intensity of diverse drought impacts, and the different adaptation techniques in place at the household level are very important [16]. The perception of drought ultimately guides an individual's adaptation behavior [20]. Rural residents who have experienced drought and have knowledge of drought and climate change would probably believe in the possibility of upcoming hazard and, as a result, would be more likely to take action to mitigate the negative effects [15].

Personal traits of smallholder farmers, such as education and age, are also crucial in shaping their perceptions [21]. Furthermore, individual farmer traits like age, prior farming experience, and wealth (capital, land, and livestock), have a significant impact on their perceptions and risk attitudes [9]. [22], opined that level of education influences perception. Smallholder farmers with training in specific specialties or at least a secondary education are more likely to accurately predict the amount of precipitation anticipated at the start of the farming season. Farmers' perceptions of drought are influenced by access to weather information and extension services. Farmers who have access to weather information and extension services are more likely to accurately estimate the quantity of precipitation at the beginning of a farming season. [23] noted that farmers' perceptions are influenced by their access to weather forecasts. [24] discovered that the frequency of extension contact and training also has an impact on farmers' perception and their choice of adaptation methods.

The threat of changing climate (drought) may be better addressed if smallholder farmers' adaptation strategies are known [25]. Smallholder farmers, who are affected most by extreme weather conditions such as drought, have a long history of risk management techniques to mitigate the effects of such events. Drought risk management (DRM) can be defined as strategies put in place to mitigate adverse effects while trying to pursue positive objectives [26]. DRM is part of climate risk management techniques that refer to decision-

making on climate mitigation strategies, where farmers use the information they receive to take action to minimize climate risk and exploit climate opportunities [27,28]. DRM tools can be divided into two: ex-ante DRM (coping mechanisms) and ex-post (adaptation mechanisms), depending on whether the strategy reduces risk exposure or minimizes the impact of undesirable outcomes after the shock [29].

More often than not, farmers living in drought-prone areas modify their production systems so that the likely effects of the shock can be minimized to acceptable levels. Ex-ante strategies are considered consumption-smoothing tools, as they help to reduce income fluctuations. There are two main ways of ex-ante coping strategies: diversification and application of flexible decision-making. Diversification involves a shift from mono-cropping to the planting of a broader range of plants and/or rearing of livestock, and engagement in other non-farm income-generating activities [30,31]. Flexible decision-making is an adaptive approach that enables farming households to switch between farm activities to help combat the risk of extreme conditions [28]. These include temporarily adjusting the use of farm resources based on climatic conditions and adjusting plant populations. Farmers in sub-Saharan Africa (SSA) have also used other DRM strategies, such as maintaining flexible decision-making (e.g., planting drought-tolerant crops), irrigation/water harvesting, and insurance against drought effects [32,33]. Depending on how serious the shock may be, farming households employ a range of ex-post DRM strategies, such as the liquidation of farm assets (e.g., land, livestock, etc.), and the reduction of consumption, particularly of non-essential items (e.g., clothing, social functions, etc.). Households sometimes also rely on insurance schemes, public relief, and safety net programmes (intervention by government and NGOs). Thus, coping and adaptation strategies are crucial in reducing rural vulnerability [15].

An important source of income in developing nations is the agricultural sector; unfortunately, this sector has been affected negatively by droughts [3]. Smallholder farmers' perception and adaptation are, therefore the key to combating drought and mitigating its impact on agriculture. Literature and research publications as to the understanding of smallholder farmers' and the people's perception of drought and its socio-cultural impacts with respect to climate change are very limited in Sub Sahara Africa (SSA). The common perception of drought is that it is a disaster, and also a hazard. Rural households most directly affected by drought generally perceive drought as a trait of life [34]. Considering the climate change situation, understanding how smallholder farmers perceive drought with its effects is important for decision-making and policy formulation. The fact that people can identify drought and its intensification will serve as a base for joint attempts to improvement in adaptation strategies. An understanding of the fact that people's actions constitute the main reason for drought, helps policymakers in selecting adaptation measures and efforts toward enhancing the people's awareness and understanding of climate variability. Drought effects on individuals and society must be identified and articulated to drive solutions and initiatives to address the effects [18]. Before the potential damage is manifested, appropriate action(s) such as adaptation and coping mechanisms must be implemented to lessen vulnerability.

Smallholder farmers' inability to adapt to drought, particularly with regards to climate change, has severe financial impacts, decreasing employment in the hinterland, influencing accessibility and costs of food, pushing a lot of people to poverty as well as causing relocation from rural to a metropolitan area. Therefore, it is important to lessen drought vulnerability and stresses to guide against future occurrences through adaptation. Article [35] describes adaptation as a change in human or natural structure in reaction to anticipated or real atmospheric stimuli or their results, which controls damage or exploits useful opportunities. Adaptation has become one of the most important tools for dealing with agricultural droughts brought on by global warming. Adapting to changing situations, stress, risks, and future opportunities is critical [1]. Absolute control system in drought, adequate understanding of the area, with a proper mastery of the hazard and vulnerability

are necessary. Drought risks and damages may be reduced if appropriate responses and decisions are taken [36].

The agricultural sector is extremely important to the country's economy [37]. Smallholder farmers' perceptions of these climate-driven derivatives, as well as their adaptation strategies, are critical for long-term development [1], since they contribute to 60% of the World's agricultural production and produce up to 80% of food in developing countries [12]. This article aims to conduct a scientometric analysis on the existing literature on perception and adaptation strategies of smallholder farmers to drought Risk (PASSFDR) using both descriptive and network analyses to assess the state of current knowledge and evaluate the level of contributions made by researchers in different continents of the world in this field of expertise. This article will add to the existing research coming from Africa. It will serve as a clarion call to offer guidance for researchers in Africa and elsewhere to do more research on Agricultural drought as this sector contributes significantly to the economy of many nations. We'll also present a list of drought adaptation/coping methods employed by farmers to deal with drought.

## 2. Methodology

### 2.1. Scientometrics

Scientometrics is the "quantitative study of communication in science and science policy" [38]. Although, from peer-reviewed research papers, popularly known as the "bibliometric" analysis of science, this area has evolved to normalize, assemble, report, and analyze extensive documents and sources of data [39]. Bibliometrix is one of the numerous software tools which can be used by scientometricians to analyze or visualize bibliometric data. It can be reviewed, changed, and improved by the knowledge workers since it is open-source software written in R-packages. The CRAN network initiative distributes and archives R (<https://cran.r-project.org/> (accessed on 1 April 2021)). Using descriptive and network analysis, we give a scientometric overview of smallholder farmers' perception and adaptation to drought vulnerability. The overall number of publications, citations, and citations per publication are all included in our descriptive analysis. The network analysis incorporates bibliographic couplings, co-events, co-references, and co-authorships.

### 2.2. Resources

Scopus database was used in the review as the largest abstract and citation database with N22,800 journals from 5000 publishers worldwide [40]. More also, [41] noted that the Scopus database is the leading multidisciplinary databank of peer-reviewed literature in the social sciences and is generally accepted and used for quantitative analyses.

### 2.3. Eligibility and Exclusion Criteria

A number of eligibility and exclusion criteria are taken into account. For speedy visibility and retrieval, we used a title-specific search. The title search was utilized due to its effectiveness as expressed by [42] who believed that a title-explicit pursuit has the benefits of insignificant misfortune, huge recuperation, and affectability over different sorts of searches like a subject, field, or creator search. First, concerning literature type, only journals and final articles were selected which means Article in Press, etc., were all excluded. Secondly, non-English articles were excluded. Thirdly, a period of 10 years was used followed by the subject area which focused on Environmental, Social, Agricultural, and Biological Sciences (see Table 1) [40], to capture most of the current perceptions and adaptation strategies of the smallholder farmers.

### 2.4. Systematic Review Process

To explore the current literature on smallholder farmers' perception and adaptation to drought vulnerability, we conducted a systematic literature review based on the rules suggested by [43]. For this study, there were four stages to the systematic review method. In March 2021, the review was completed. The first phase defined the terms that will be

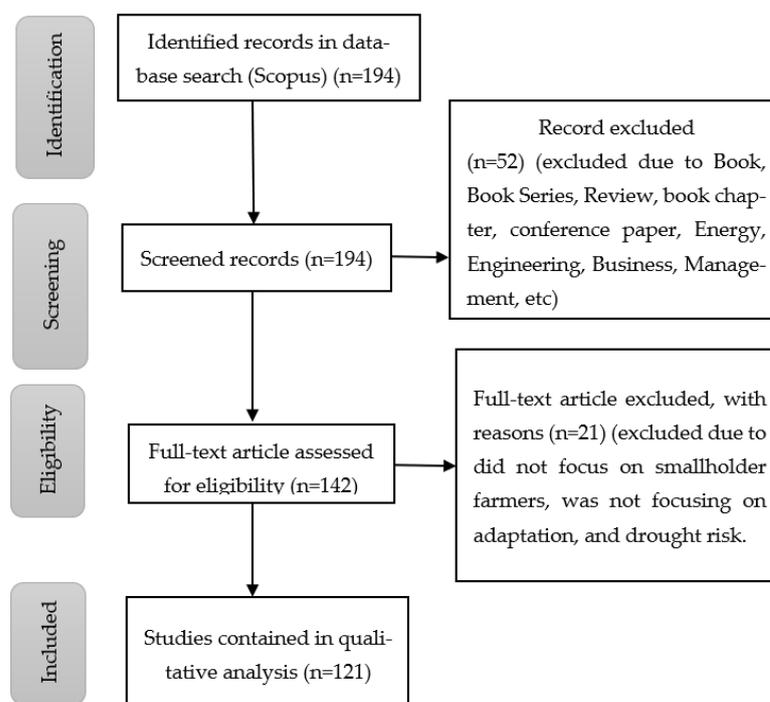
utilized in the search. Keywords relating to smallholder farmers’ perceptions and adaptations to drought vulnerability were utilized, with a total of 194 published records retrieved, based on prior studies (Table 2). The screening stage came next. A total of 52 articles were deleted from the ( $n = 194$ ) that were not eligible to be reviewed at this stage. The reason for removing these articles was due to the fact that most of them were not truly focusing on (PASSFDR). At the eligibility stage, a total of ( $n = 21$ ) papers were removed after a thorough review since some did not focus on smallholder farmers, perception, adaptation, drought, or vulnerability. A total of ( $n = 121$ ) papers were chosen for qualitative analysis (Figure 1).

**Table 1.** Criteria for inclusion and removal.

Criterion	Eligibility	Exclusion
Document type	Article	Review, book chapter, conference paper
Source type	Journals	Book, Book Series
Publication stage	Final	Article in Press
Subject area	Environmental Science, Social Sciences, Agricultural, and Biological Sciences	Energy, Engineering, Business, Management and Accounting, Medicine, Biochemistry, Genetics, and Molecular Biology, Business, Management and Accounting, Economics, Econometrics, and Finance.
Language	English	Non-English
Period	Between 2011–2020	<2011, & >2020

**Table 2.** The used systematic review search string.

Database	Keywords Used	Records
Scopus	TITLE("drought vulnerab*" OR "drought risk*" OR "drought susceptib*" OR "drought threat*" OR "drought denger*" AND "percept*" OR "aware*" AND "adapt*" OR "adapt* measure*" OR "adapt * techniq*" OR "coping strateg*" OR "coping measure*" OR "coping mechanism" AND "smallholder farmers")	194



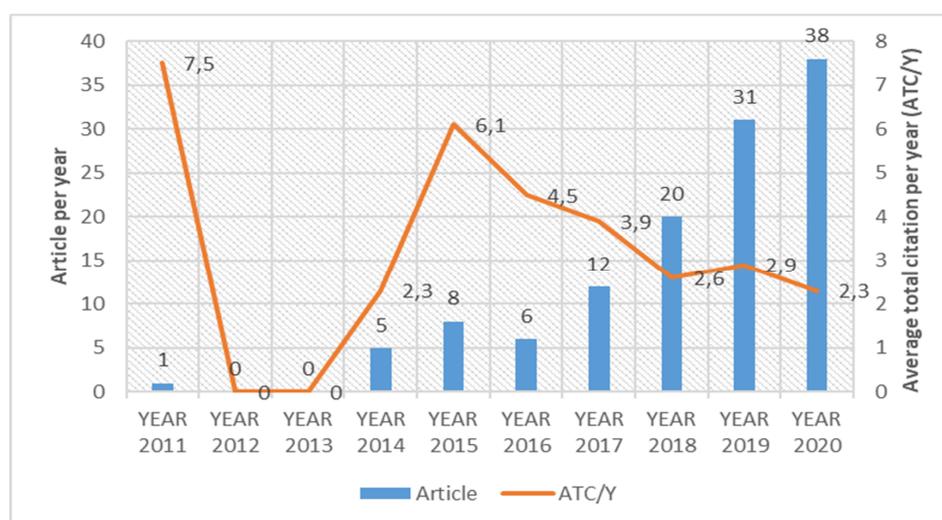
**Figure 1.** Articles extraction flow chart diagram. Modified from [44].

### 2.5. Data Processing and Analysis

This research assessed data obtained for scientometric analysis applying RStudio v.3.4.1 program with bibliometrix R-package after reading through the articles relevant to the study. Information was imported into RStudio and changed over to a bibliographic information outline and standardized for duplicate matching [45,46]. For visualization, the names, keywords (DE), and keywords-plus (ID) of the authors, were also mined. The information was extricated by perusing the abstracts and then the whole articles to find relevant topics and sub-topics. Qualitative analysis was accomplished by utilizing content analysis to recognize subjects related to smallholder farmers' perception and adaptation to drought risk [40]. These articles were selected for descriptive and bibliometric analysis.

### 3. Results and Discussion

In total 121 papers were published in the Scopus database during the study period, and their characteristics are listed in Table 3. Focusing on the authorship dataset, the research contained 440 authors, with 0.275 articles per author (3.64 authors per article), 3.88 co-authors per article, and a collaboration index (CI) of 3.77 except for six authors publishing as sole author, all 434 authors were involved in multi-authored documents. This suggests that multiple authors sustained the PASSFDR research efforts. "The Author Collaboration Index (CI) is obtained as the ratio of the authors of multi-authored documents and total multi-authored documents" [47]. During the study period, an average of 9.826 citations per article were obtained, indicating that some papers have a large amount of citations while others have fewer. The research-based turnout relating to the PASSFDR study by Lotka's law indicated a beta coefficient and constant of 4.06 and 0.72, respectively, with Kolmogorov-Smirnoff goodness of fit  $R^2$  of 0.90. Figure 2 depicts published studies on PASSFDR from 2011 to 2020, it also shows the average total number of citations per article per year. The yearly growth rate was 68.14 percent, with a mean of  $12.1 \pm 6.05$  and a range of (1–38), indicating that PASSFDR research has grown over time. This outcome could be linked to the works of [48] who suggested drought risks are expected to rise as a result of climate change. The result also agrees with the research of [49] who opined that there have been some numerous and quickly expanding number of studies on drought. During the survey period, research production varied and peaked in 2020 (accounting for 31.6 of total published work). Also, the mean total citations of published articles varied over the years, with 2011 as the highest cited document (average = 7.5).



**Figure 2.** From 2011 through 2020, annual scientific productivity for PASSFDR publications indexed in Scopus. ATC/Y stands for average total citations of published papers per year. NB The annual percentage rate of increase is 68.14.

**Table 3.** The primary information about the data utilized in this study.

Description	Results
No of articles	121
Sources (Journals)	66
Keywords plus (ID)	644
Author's keywords (DE)	406
Timespan	2011:2020
Average years from publication	2.74
Average citations per article	9.826
Average citations per year per doc	2.146
References	8.461
<b>Document types</b>	
Article	121
<b>Document contents</b>	
Authors	440
Author appearances	470
Authors of single-authored documents	6
Authors of multi-authored documents	434
<b>Authors collaboration</b>	
Single-authored documents	6
Documents per Author	0.275
Authors per document	3.64
Co-authors per documents	3.88
Collaboration index	3.77

According to [50], a country's influence in a given research sector can be quantified using a variety of metrics, which include;

1. The most cited country.
2. Highly cited article.
3. The number of articles with a high impact factor.
4. Most referred article.
5. The number of citations from articles with a high impact factor.
6. A country's most relevant and prolific affiliation.
7. Most productive authors.
8. Country of origin of the corresponding author and the number of articles produced by that country.

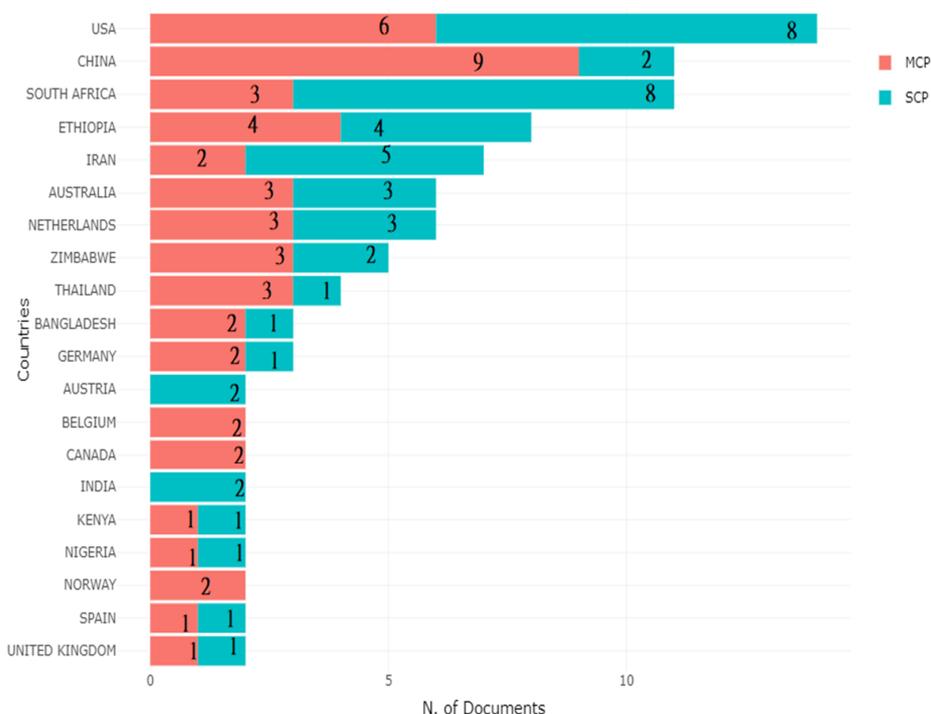
This section focuses on two key indicators: the nation of the corresponding authors and the number of papers published in that nation as well as the nation that has been referenced the most. Figure 3 and Table 4 demonstrate the research output connected to PASSFDR for the top 20 most active nations. In terms of the overall number of articles ( $n = 14$ , 13%) and total citations ( $n = 244$ ), the United States of America came out on top. The reason for this, is that some of the corresponding authors either have one or two affiliations with USA-based universities (Michigan State University, Cornell University). China and South Africa has ( $n = 11$ , 10.2%) each, followed by Ethiopia ( $n=8$ , 7.4%), Iran ( $n = 7$ , 6.5%), Australia and Netherlands has ( $n = 6$ , 5.6%) each, Zimbabwe ( $n = 5$ , 4.6%), Thailand ( $n = 4$ , 3.7%), Bangladesh and Germany has ( $n = 3$ , 2.8%), Austria, Belgium, Canada, India, Kenya, Nigeria, Norway, Spain, and United Kingdom all has ( $n = 2$ , 1.9%). The top nations' publishing frequency vary from (1.9 to 13.0). When productivity was assessed by the number of citations per nation, the ranking of these countries altered, with only the United States of America maintaining the same position. This result corresponds to the research of [51] that the United States has a strong intellectual influence, with the majority of top-cited articles coming from research centers and institutions linked with the United States (Michigan State University, Cornell University). Ranking total citation per country in terms of continents, Asia as a continent with (Australia, China, Thailand, Bangladesh, Iran, India, and Indonesia [ $n = 160$ , 71, 45, 30, 26, 11, 9]) respectively, is ranked first with 33.4% from the top 20 most productive countries in PASSFDR documents indexed in Scopus from 2011 to 2020. In Southeast Asia, where farming is a key source of income,

maize, and rice among other crops are produced on over 115 million acres of land. The main constraint on rice production, which is also one of its biggest problems, is drought. Changing climate (drought) is and will continue to be a significant factor affecting production in the area because the majority of its economy depends on agriculture and natural resources as its principal sources of revenue [52], thus many citations are expected to come from (Thailand and Indonesia). The second in rank is America’s continent 25.8% with (USA, Canada, and Chile [*n* = 244, 14, 14]) respectively. The third and fourth continents were Africa and Europe with 25.6%, and 15.1% respectively.

**Table 4.** Top 20 most productive nations by corresponding authors in the PASSFDR documents indexed in Scopus (2011–2020).

Productivity According to Number of Articles Published						Productivity According to the Number of Citations Per Country			
Rank	Country	Articles	Freq %	SCP	MCP	Rank	Country	TC	AAC
1	USA	14	13.0	8	6	1	USA	244	17.4
2	China	11	10.2	2	9	2	Australia	160	26.6
2	South Africa	11	10.2	8	3	3	Kenya	101	50.5
3	Ethiopia	8	7.4	4	4	4	Ethiopia	77	9.6
4	Iran	7	6.5	5	2	5	China	71	6.5
5	Australia	6	5.6	3	3	6	Germany	48	16.0
5	Netherlands	6	5.6	3	3	7	Netherlands	46	7.7
6	Zimbabwe	5	4.6	2	3	8	Thailand	45	11.3
7	Thailand	4	3.7	1	3	9	Zimbabwe	34	6.8
8	Bangladesh	3	2.8	1	2	10	Nigeria	32	16.0
8	Germany	3	2.8	1	2	11	Bangladesh	30	10.0
9	Austria	2	1.9	2	0	12	Iran	26	3.7
9	Belgium	2	1.9	0	2	12	South Africa	26	2.3
9	Canada	2	1.9	0	2	13	Austria	24	12.0
9	India	2	1.9	2	0	13	Norway	24	12.0
9	Kenya	2	1.9	1	1	14	Spain	17	8.5
9	Nigeria	2	1.9	1	1	15	Canada	14	7.0
9	Norway	2	1.9	0	2	15	Chile	14	14.0
9	Spain	2	1.9	1	1	16	India	11	5.5
9	United Kingdom	2	1.9	1	1	17	Indonesia	9	9.0

MCP: Multiple country production, SCP: Single country production.



**Figure 3.** Top 20 most productive nations in PASSFDR documents indexed in Scopus (2011–2020). MCP: Multiple country production, SCP: Single country production.

Figure 4 and Table 5 show the top journals with the most PASSFDR articles published. Several institutions urge their scholars to publish their findings in high-impact journals

with a large number of citations and a wide readership [53,54]. These relevant sources encompass a wide range of topics in their respective articles. Climate change, disaster risk, management, agriculture, and the environment were all prominent themes in most of the journals, the Journal of Sustainability (Basel, Switzerland) came out on top. With ( $n = 8$ , 6.6 percent), the International Journal of Disaster Risk Reduction came in second. Journal of Climatic Change was ranked third with ( $n = 6$ , 5.0%), followed by the International Journal of Climate Change Strategies and Management ( $n = 5$ , 4.1%). Climate and Development, Jamba: Journal of Disaster Risk Studies, Natural Hazards, and Water (Basel, Switzerland) were ranked fourth with the same number of published articles ( $n = 4$ , 3.3%). Fifth in rank were Land Use Policy and Weather Climate and Society with ( $n = 3$ , 2.5%) published articles. Agricultural Systems, Agriculture and Food Security, Climate Risk Management, Environmental Management, Environmental Science and Pollution Research, Global Environmental Change, International Journal of Agricultural Sustainability, International Journal of Agricultural Technology, International Journal of Disaster Risk Science, International Journal of Environmental Research and Public Health were ranked seventh with ( $n = 2$ , 1.7%) each in the number of published articles on PASSFDR.

It is believed that author keywords and keywords-plus provide sufficient information about the article's topics which include the information that the author wants to convey to their audience [55]. Table 6 shows the top twenty most important authors' keywords in relation to PASSFDR studies, incorporating both Authors Keywords (DE) and Keyword-Plus (ID) in the article mined from the Scopus database. The top eight author keywords (DE) in descending order, drought occurred in ( $n = 26$ , 21.5%) articles, adaptation ( $n = 23$ , 19%), agriculture ( $n = 17$ , 14%), smallholder farmers ( $n = 9$ , 7.4%), resilience ( $n = 8$ , 6.6%), climate variability ( $n = 7$ , 5.8%), vulnerability ( $n = 6$ , 5.0%), adaptive capacity ( $n = 5$ , 4.1%). The reason why drought appeared (26 & 67) in authors' keywords and keywords-plus is because throughout the world drought is ranked first among all the natural hazards accounting for about 5% of natural disasters and about 30% of losses of all casualties comes disaster [6]. More also, Keyword-plus (ID) showed that drought had the highest number of occurrences in the articles reviewed ( $n = 67$ , 55.4%), adaptive management ( $n = 33$ , 27.3%), climate change ( $n = 32$ , 26.4%), agriculture ( $n = 30$ , 24.8%), smallholder farmers ( $n = 29$ , 24.0%), vulnerability ( $n = 21$ , 17.3%), climate effect and perception have the same number of articles ( $n = 18$ , 14.9%). There are nine (9) keywords in common between author keywords (DE) and Keyword-plus (ID), (climate change, drought, agriculture, smallholder, vulnerability, climate change adaptation, risk, Africa, and Ethiopia). These can be ascribed to the many hotspots and the evolution of PASSFDR research used in this field. Africa and Ethiopia appeared as dominant continents and countries in author keywords (DE) and keyword-plus (ID). This might be due to the large number of authors or the frequent use of Africa and Ethiopia as case studies in the discipline [56,57].

**Table 5.** The top 20 most useful sources in the PASSFDR papers indexed in Scopus (2011–2020).

Sources	Article	% of 121
Sustainability (Switzerland)	10	8.3
International journal of disaster risk reduction	8	6.6
Climatic change	6	5.0
International journal of climate change strategies and management	5	4.1
Climate and development	4	3.3
Jamba: journal of disaster risk studies	4	3.3
Natural hazards	4	3.3
Water (Switzerland)	4	3.3
Land use policy	3	2.5
Weather climate and society	3	2.5

Table 5. Cont.

Sources	Article	% of 121
Agricultural systems	2	1.7
Agriculture and food security	2	1.7
Climate risk management	2	1.7
Environmental management	2	1.7
Environmental science and pollution research	2	1.7
Global environmental change	2	1.7
International journal of agricultural sustainability	2	1.7
International journal of agricultural technology	2	1.7
International journal of disaster risk science	2	1.7
International journal of environmental research and public health	2	1.7

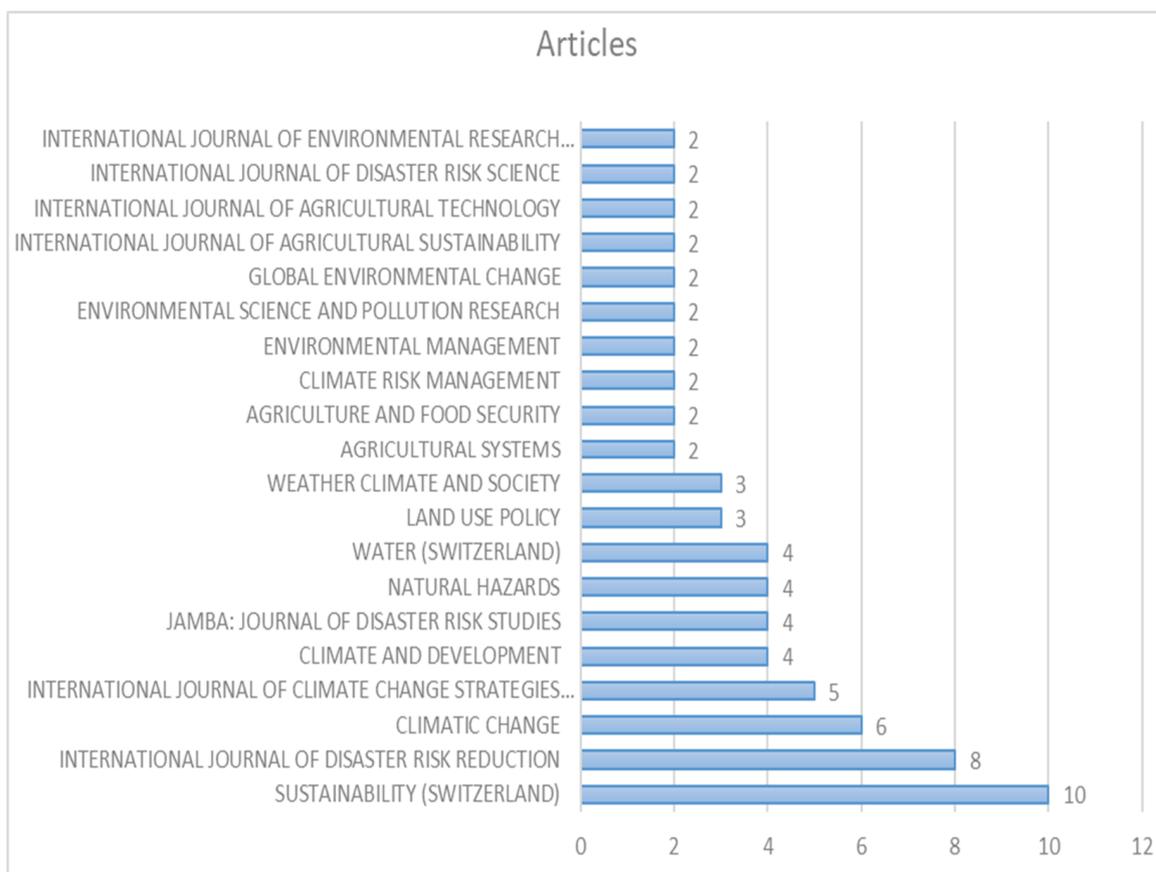


Figure 4. Top 20 most relevant sources.

Figure 5 shows the results of a word cloud of the 50 most commonly occurring author’s keywords in PASSFDR investigations. During the analytic period, a word cloud summarized the most common important phrases used by writers on PASSFDR research. The magnitude of each keyword in the word cloud network indicates its importance and frequency in the PASSFDR literature. It could be deduced that the nearer the keywords are to one another, the more possible their interaction in the literature throughout the study period [51]. The word cloud depicts the most often used words in PASSFDR research, making it simple to spot key areas of interest in this specialty. Drought, adaptation, smallholder farmers, agriculture, climatic variability, resilience, vulnerability, and adaptive capacity, for example, were found to be some of the most common terms in PASSFDR. Other predominant keywords are protection motivation theory, climate adaptation, risk, Africa, Ethiopia, livelihood, coping, perception, etc. This further confirms the important areas that researchers are focusing on in drought-related research. It, therefore, means that

the agricultural sector which is the main source of livelihood for farmers needs to have proper adaptation strategies in place to mitigate the effect of drought.

**Table 6.** Top 20 most important keywords in the PASSFDR documents indexed in Scopus (2011–2020).

S/N	Author Keywords (DE)	Articles (% of 121)	Keywords-Plus (ID)	Articles (% of 121)
1	Drought	26 (21.5)	Drought	67 (55.4)
2	Adaptation	23 (19.0)	Adaptive management	33 (27.3)
3	Agriculture	17 (14.0)	Climate change	32 (26.4)
4	Smallholder farmers	9 (7.4)	Agriculture	30 (24.8)
5	Resilience	8 (6.6)	Smallholder farmers	29 (24.0)
6	Climate variability	7 (5.8)	Vulnerability	21 (17.3)
7	Vulnerability	6 (5.0)	Climate effect	18 (14.9)
8	Adaptive capacity	5 (4.1)	Perception	18 (14.9)
9	Africa	5 (4.1)	Risk assessment	16 (13.2)
10	Climate variability	5 (4.1)	Crop production	12 (10.0)
11	Ethiopia	5 (4.1)	Food security	12 (10.0)
12	Protection motivation theory	5 (4.1)	Maize	11 (9.1)
13	Climate change adaptation	4 (3.3)	Agricultural worker	10 (8.3)
14	Livelihoods	4 (3.3)	Bangladesh	10 (8.3)
15	Risk	4 (3.3)	Decision making	10 (8.3)
16	Climate smart agriculture	3 (2.5)	Strategic approach	10 (8.3)
17	Coping	3 (2.5)	Ethiopia	9 (7.4)
18	Crop insurance	3 (2.5)	Zea mays	9 (7.4)
19	Exposure	3 (2.5)	Africa	8 (6.6)
20	Farmers	3 (2.5)	Article	8 (6.6)



**Figure 5.** Word cloud showing the top 50 most often used authors' keywords in PASSFDR publications indexed in Scopus (2011–2020).

The information in Figures 6–8 presents the collaboration network analyses of authors', institutions, and countries respectively in PASSFDR research during the period of investigation (2011 to 2020). This network analysis shows the robustness and occurrence of 50 authors, organizations, and nations. In the diagrams, each colored node signifies an author, an organization, and a nation meanwhile the connecting lines illustrate the frequency of cooperation and the node diameter denotes the strength of the partnership. In the collaboration network, the thicker the line connecting them, the stronger the association between them and vice versa [58]. The outcome in Figure 6 showed that authors like

Fisher [56,59], have the strongest collaboration. [56] happens to be the author with the greatest number of published papers (five) within the period under review. The second stronger collaboration network is the association among Akhtar, Faisal, and Raza. The results of the collaboration network analysis for institutions (Figure 7) revealed that Nanjing Agricultural University has the largest node, indicating that it has the highest frequency and strength of collaboration. The Nanjing Agricultural University has the strongest links with Dilla University in Ethiopia and the National and Local Joint Engineering Research Center for Rural Land Resources Use and Consolidation in China. Along with the Nanjing Agricultural University, other institutions such as the University of Kwazulu-Natal, the University of Zimbabwe, the International Crop Research Institute for the Semi-Arid Tropics, Michigan State University in the United States, and Cornell University in the United States were also ranked among the top six with strong collaborative strength. In Figure 8, the United State of America and China is ranked first and second respectively with the strongest collaborative strength. While South Africa, Ethiopia, and Zimbabwe were ranked third, fourth and fifth respectively. There is a strong collaboration network between South Africa and Zimbabwe. [60], citing the works of [61–63], noted that there are several adaptation/coping mechanisms to drought disaster, which include crops or livestock diversification, improving irrigation, and growing shade-giving plants for agriculture, among others. Table 7 presents a list of some of the adaptation/coping strategies employed by the farmer to mitigate the adverse effect of drought in their various locations.

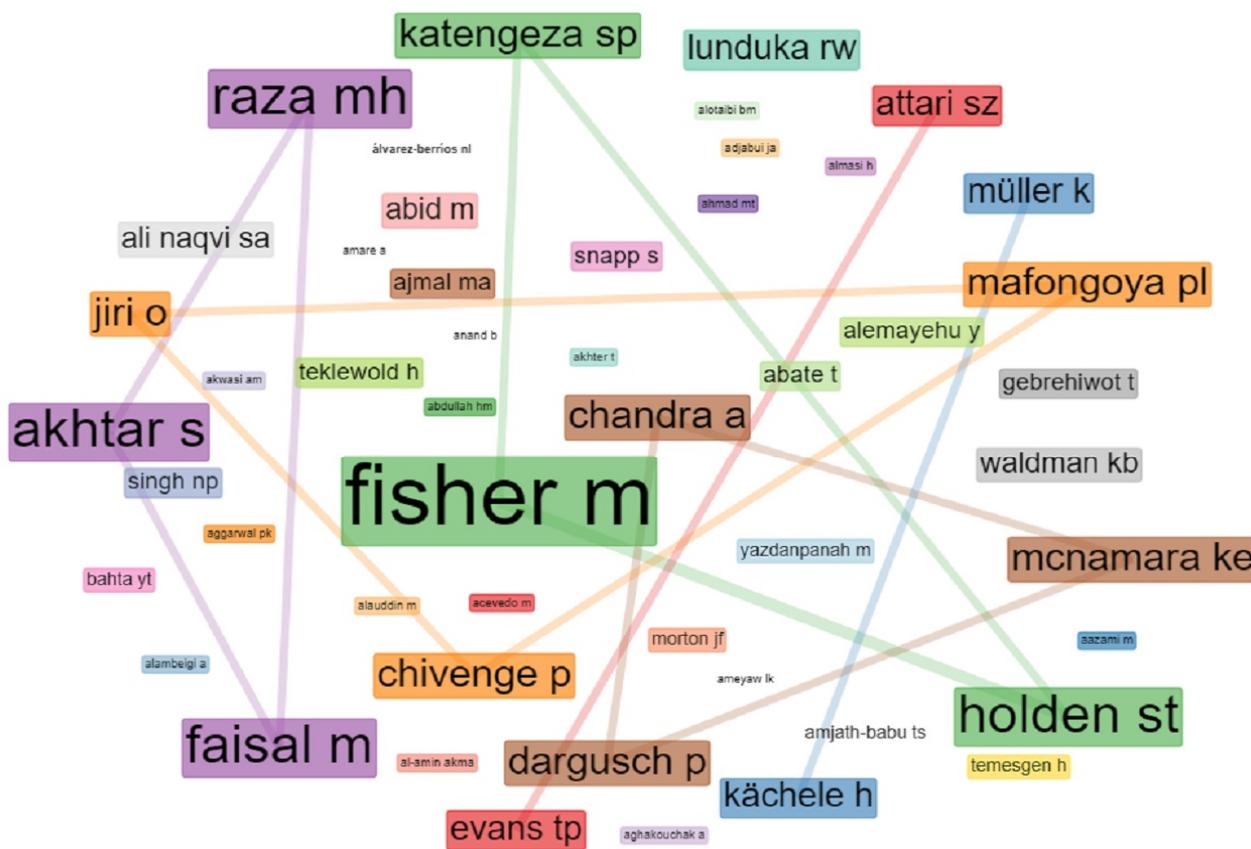


Figure 6. Collaboration network for the top 50 authors in PASSFDR studies indexed in Scopus from 2011 to 2020.

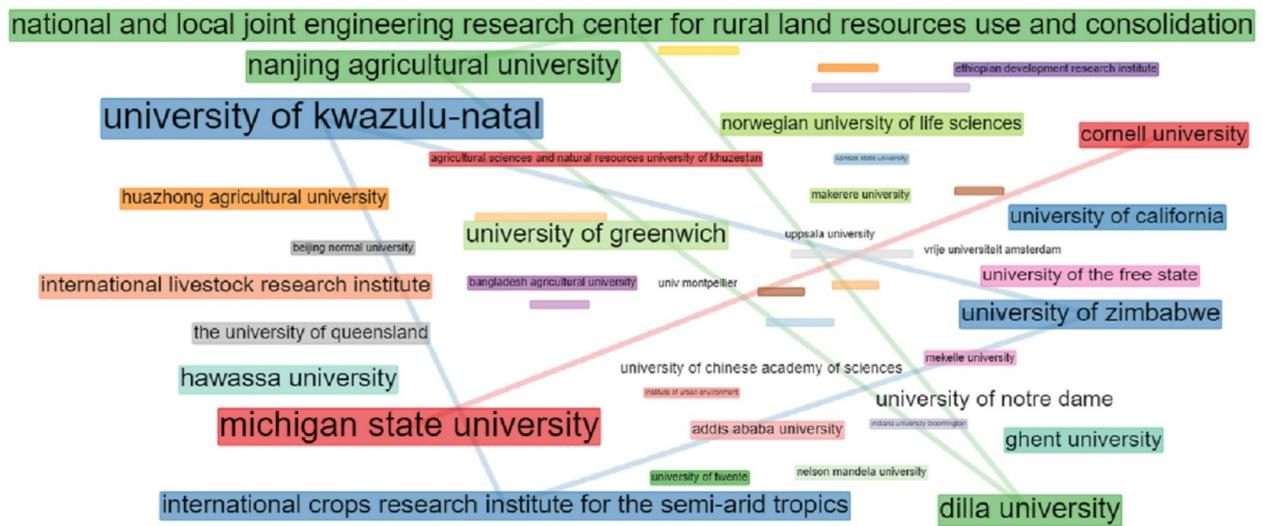


Figure 7. Collaboration network for the top 50 institutions in PASSFDR studies indexed in Scopus from 2011 to 2020.

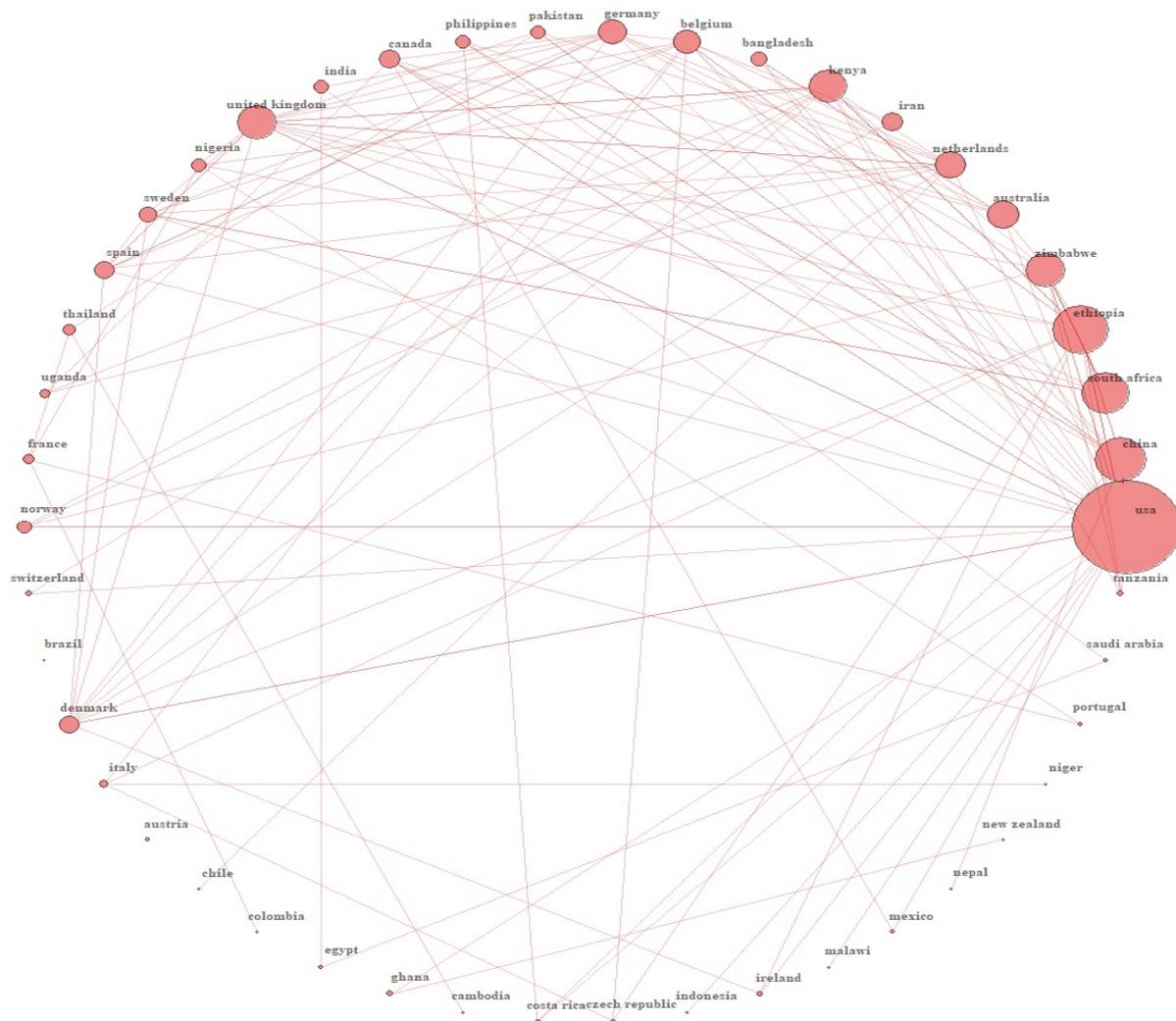


Figure 8. Countries' collaboration networks on PASSFDR studies indexed in Scopus from 2011 to 2020.

**Table 7.** List of adaptation/coping mechanisms used by farmers to mitigate drought.

S/n	Topic	Adaptation/Coping Strategies	Author(s)
1	Drought coping strategies followed by dairy farmers in the Bundelkhand region of Uttar Pradesh	Storing wheat straw and other crop residues (gram/lentil/mustard/linseed, etc.) in advance for meeting their feed shortage; providing feed and water twice a day and using crop residues (wheat straw/bhusa, paddy straw, jowar stover).	[64]
2	Agro-pastoral choice of coping strategies and response to drought in the semi-arid areas of Uganda	Diversification of income sources, changing cropping systems, and looking for external support	[65]
3	Farmer's perception and adaptation practices to cope with drought: Perspectives from Northwestern Bangladesh	To cope with drought, rainwater collection (harvesting) and water resource extraction are performed.	[66]
4	Coping and Adaptation Strategies For Agricultural Water Use During Drought Periods	Cultivating and watering tiny areas in order to conserve water. To save water, mountain water is harvested, boreholes are drilled, and stock dams are built. To boost their livestock feed, they buy lucerne from others. Animals are also slaughtered or sold by farmers. Selling their cattle before the drought has a negative impact on its quality. Drought-tolerance herds and low-input systems are also used in the long run to adapt to drought. Fruit growers planted short-season cash crops to enhance cash flow and shift their systems to higher-value crops and businesses.	[4]
5	Smallholder farmers' perceived evaluation of agricultural drought adaptation technologies used in Uganda: Constraints and opportunities	The most efficient, effective, acceptable, and urgent performance measures were drip irrigation systems ( $p < 0.05$ ). For all of the performance indicators assessed ( $p < 0.05$ ), the rainwater harvesting systems used were thought to be significant.	[67]
6	Smallholder farmers' adaptation to drought: Identifying effective adaptive strategies and measures	Water-use restrictions	[9]

#### 4. Conclusions

This study has provided helpful insight into PASSFDR research in agriculture. Using a bibliometric method, a complete analysis of the overall development circumstances of the PASSFDR area of study from 2011 to 2020 was undertaken using the Scopus database. For the past decade, this study has demonstrated scientific advancement in the area of PASSFDR, with a robust evolution. During the year under consideration, the field grew at a steady rate of 68.14 percent per year in terms of continuous publication output. The number of articles has continued to rise, indicating that PASSFDR is becoming a more popular topic. In terms of research production at the national level, the United States, in particular, takes the lead with the highest number of publications and, as a result, the biggest academic influence, with the biggest number of top article citations coming from USA-connected institutions and research centers. This gives the United States a leadership position in PASSFDR research, allowing it to collaborate with other countries and provide grant or funding opportunities. The top four most relevant sources accounted for 24% of all publications in this category, with Sustainability (Basel, Switzerland) coming out on top, followed by the International Journal of Disaster Risk Reduction. Climate change, drought, adaptation, agriculture, smallholder farmers' resilience, and vulnerability are the challenges associated with climate change, according to clustering analysis and frequency analysis of the top most often used terms in the field of PASSFDR.

The word cloud which depicts the most often used words in PASSFDR research has shown the extent of each keyword. It is feasible to deduce that the closer the keywords are to one another, the more conceivable their interaction in the literature throughout the research period. The network collaboration of authors has revealed the strongest collaboration among Fisher, Holden, and Katengeza possibly because they have the highest number of published articles within the period of review. According to the collaboration network analysis for institutions in Figure 7, Nanjing Agricultural University (NAU) has the highest strength and frequency of association. NAU is one of China's oldest and most famous agricultural universities, administered by the Ministry of education. The list of adaptation

and coping strategies provided serves as a guide for farmers to mitigate drought risk, while that of drought indices serves as a guide for researchers to know the appropriate drought indices to apply for any given task relating to drought.

A summary of the study on PASSFDR was provided, including information on keywords, keyword plus, most cited articles, nations, journals, institutions, authors, and research advancements. Over the last decade, there has been a considerable rise in PASSFDR research. Hinged upon the top keyword, adaptation and drought are at the core of concerns linked to PASSFDR, providing a suggestion on the relationships between adaptation and drought for future research. An additional study highlighting the impact of drought on smallholder farmers, as well as institutional improvement of drought perception and adaptation strategies with regards to smallholder farmers, are needed at this time. This research is intended to expedite and add to PASSFDR research erudition. This study also provides a road map for navigating the conceptual conundrum of PASSFDR research as well as recommendations for future research in this area of specialty. This research concludes that there is indeed a global growth in PASSFDR research, with significant research output coming from America and the Asian continent compared to African and European continents. It is very important to enhance collaboration among authors, institutions and countries in the field of PASSFDR research as this could lead to more scientific and practical solutions to drought risk mitigation.

#### Limitations of the study

In order to achieve the objective of the study, a scientometric study was undertaken using publications indexed in Scopus. Currently, bibliometric analyses on numerous fields and topics may be obtained from multiple well-curated bibliographic databases, such as Web of Science, Google Scholar, and Director of open access journal. Scopus is widely regarded as one of the most comprehensive curated databases, with content ranging from conference proceedings to book chapters to scientific publications, etc. Since the information reported in conference papers is frequently not published in scientific publications, the conference proceedings were not examined. Further research on PASSFDR should consider combining more databases such as ScienceDirect, Web of Science, Google Scholar, and Directory of Open Access Journals among others. Secondly, further research on PASSFDR should consider going below the year 2011 as this research focused on the past decade to get the current perceptions and adaptation strategies employed by smallholder farmers to mitigate drought.

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