# A Bibliometric Analysis of Climate Smart Agriculture Research Using VOSviewer

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**Submission date:** 27-Feb-2023 09:59AM (UTC+0700)
**Submission ID:** 2023774334
**File name:** alysis_of_Climate_Smart_Agriculture_Research_Using_VOSviewer.pdf (3.66M)
**Word count:** 926
**Character count:** 5522

Moroccan Journal of Chemistry
ISSN: 2351-812X
http://revues.imist.ma/?journal=morjchem&page=login
Senny & al. / Mor. J. Chem. 10 N°3 (2022) 488-499
DOI: https://doi.org/10.48317/IMIST.PRSM/morjchem-v10i3.33077

# A Bibliometric Analysis of Climate Smart Agriculture Research Using VOSviewer

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*Received 30 Oct 2020,*
*Revised 15 Feb 2020,*
*Accepted 11 Jun 2022*

## Abstract

Climate-Smart Agriculture (CSA) is an approach used to modify and redirect existing agricultural systems to support food security in climate change. The purpose of this research is to conduct a bibliometric analysis in terms of CSA by combining mapping analysis using VOSviewer software. The bibliometric and descriptive quantitative approach was applied in this research. The data obtained is a search result based on the keyword "climate smart agriculture" in Google Scholar. From the search results, 999 articles published were found in the range of 2017-2021. However, there are only 132 articles that are relevant to the research topic. The results show that research on climate smart agriculture increased in 2017-2019 but decreased in 2020. Moreover, the research increased significantly in 2021. In conclusion, this study shows the importance of conducting a bibliometric analysis, especially in the field of climate smart agriculture. It is hoped that this research can be a reference for future research in conducting and determining research themes.

***Keywords:*** *Bibliometric, Climate smart agriculture, Data analysis, VOSviewer.*

## 1. Introduction

Climate change has the potential to damage agricultural productivity and raises the vulnerability of those who rely on agriculture for a living. Furthermore, climate change might destabilize agricultural markets, putting food supply at risk across communities. Climate-Smart Agriculture (CSA) is a method of modifying and redirecting current agricultural systems to ensure food security in climate change. Existing challenges may be mitigated by developing resilience and resource efficiency in agricultural production systems, as well as farmers' adaptive capabilities [1]. Since Climate Smart Agriculture needs to be integrated with technology, things such as pesticides, land management, inorganic fertilizers, and others, have to be adapted to an advanced technology [2]. With the emergence of climate-smart agriculture, the communities may use this advancement to improve their standard of living. The emergence of climate-smart agriculture can also be an opportunity for researchers to improve their research on a specific topic. To determine the enormous prospects for study on specific themes, research in each sector, including Climate Smart Agriculture, must be examined bibliometrically [3]. It is because bibliometrics has been used to categorize a specific topic in the form of a bibliography as well as to generate a representative summary of the topic chosen [4]. VOSviewer is one of the tools that may be used to conduct a bibliometric analysis. VOSviewer is software that can generate, visualize, and analyze bibliometric maps. VOSviewer can evaluate various sorts of bibliometric network data, including connections between publications or journal citations, associations between scientific terminology, and collaborative relationships between researchers [5]. Previous research regarding Climate Smart Agriculture has been carried out by several researchers, including research by Morkunas and Balezentis. This research discussed literature analysis regarding Climate Smart Agriculture [6]. Another research by Hrabanski et al. discussed the contribution of CSA, NBS, and agroecology to agricultural climatization and integration into the international climate agenda [7]. Research by Jagustović et al. regarding Climate Smart Agriculture explained the investigation of synergies and exchanges through CSA and system dynamics [8]. Another research conducted by Al Husaeni and Nandiyanto was regarding bibliometric analysis of engineering research using VOSviewer and its correlation with the pandemic of COVID-19 [9]. Yu et al. also conducted a quantitative analysis and its characteristics of the Support Vector Machine (SVM) development trend in China from 2000 to 2018 [10]. However, research on bibliometric analysis regarding climate-smart agriculture is still lacking, especially by utilizing VOSviewer software as a tool in conducting the mapping analysis. Therefore, this research aims at conducting bibliometric analysis research in the field of climate-smart agriculture by integrating mapping with VOSviewer software. It is because this analysis is important to determine the quantity and novelty of the data. It is hoped that this research can be a resource for academics in performing and deciding on research subjects, particularly those connected to climate-smart agriculture.

## 2. Materials and methods

The bibliometric and descriptive quantitative approaches were applied in this research. In this study, we gathered information from published journals that were indexed by Google Scholar. It is because Google Scholar is one of the journal sources that can be accessed easily. We also conducted a literature study on the topic of our research using Publish or Perish software. We chose Publish or Perish software to identify the bibliometric data from our research topic [9]. Furthermore, we stored the data from the Publish or Perish program into files that could be used in the VOSviewer software. We used Publish or Perish 8 and VOSviewer 1.6.17 in this research as the software to collect the data. In this research, we filtered the materials and only used those that were relevant to climate smart agriculture. We retrieved the data from Google Scholar by entering the keyword "climate smart agriculture" according to the title, keywords, and abstract requirements in Publish or Perish software. We obtained 999 data regarding climate-smart agriculture research. However, after filtering the data collected, 132 related journals were obtained. The publications

considered in this study were published between 2017 and 2021. The articles gathered are then stored in *.ris format. After that, we used the VOSviewer software to generate the visualization and analyze trends in the form of bibliometric maps. We mapped the article data from the prepared database sources. VOSviewer software mapping data is classified into three types: network, overlay, and density visualization. Furthermore, we filter the terms included in the VOSviewer mapping visualization.

## 3. Results and Discussion

### 3.1. Research developments in the field of climate-smart agriculture

Figure 1 depicts the development of CSA research from 2017 to 2021. According to Figure 1, the development of CSA research during the previous five years, specifically from 2017 to 2021, has grown in 2017-2019 but declined again in 2020. However, in 2021, the number of publications increased significantly. This is evidenced by the fact that the number of articles in 2017 reached 14 before increasing to 20 in 2018. The number of articles increased again in 2019 to as many as 31. However, by 2020, the number of articles had dropped to 27. Nevertheless, the number of publications increased significantly again in 2021, reaching 40.


**Figure 1.** Levels of development of research on climate-smart agriculture

Figure 1 shows that research regarding climate-smart agriculture is increasing every year, starting from 2017. Despite the fact that research about climate smart agriculture declined in 2020, in 2021, it increased significantly that the number of papers reached 132. In addition to the search results that have been done on Publish or Perish, we got 132 articles that match the research topic. From these data, we have filtered 20 articles with the most citations from 20 different journals (see Table 1). Table 1 shows data from 20 articles that match the research criteria. From the 20 selected articles, it is shown that the highest citation related to Climate-Smart Agriculture was 179, while the lowest citation was 5. Table 1 also shows that in 2017 and 2021 each only has one article with the highest citation. In 2018, the most cited articles were 5 articles. Meanwhile, in 2020, the articles that were widely cited were 3 articles. The year with the most citations was 2019 with 10 articles.

**Table 1.** Article Data in the Field of Climate Smart Agriculture

| No | Authors | Title | Year | Cites | Refs |
|---|---|---|---|---|---|
| **1.** | Taylor | Climate-smart agriculture: what is it good for? | 2018 | 179 | [11] |
| **2.** | Partey et al. | Developing climate-smart agriculture to face climate variability in West Africa: challenges and lessons learnt | 2018 | 99 | [12] |
| **3.** | Makate et al. | Increasing resilience of smallholder farmers to climate change through multiple adoption of proven climate-smart agriculture innovations | 2019 | 95 | [13] |
| **4.** | Chandra et al. | The relevance of political ecology perspectives for smallholder Climate-Smart Agriculture: a review | 2017 | 35 | [14] |
| **5.** | Makate et al. | Farm household typology and adoption of climate-smart agriculture practices in smallholder farming systems of southern Africa | 2018 | 28 | [15] |
| **6.** | Aryal et al. | Agricultural sustainability under emerging climatic variability: the role of climate-smart agriculture and relevant policies in India | 2020 | 27 | [16] |
| **7.** | Zougmoré et al. | Science-policy interfaces for sustainable climate-smart agriculture uptake: lessons learnt from national science-policy dialogue platforms in West Africa | 2019 | 22 | [17] |
| **8.** | Hammed et al. | Enhancing growth and yield of crops with nutrient-enriched organic fertilizer at wet and dry seasons in ensuring climate-smart agriculture | 2019 | 21 | [18] |
| **9.** | Khoza et al. | Understanding gender dimensions of climate-smart agriculture adoption in disaster-prone smallholder farming communities in Malawi and Zambia | 2019 | 15 | [19] |
| **10.** | Tran et al. | Determinants of adoption of climate-smart agriculture technologies in rice production in Vietnam | 2019 | 14 | [20] |
| **11.** | Bohm, & Klein | The concept of climate smart agriculture–a classification sustainable theories | 2020 | 14 | [21] |
| **12.** | Mathews et | Climate-smart agriculture for sustainable agricultural sectors: The case of Mooifontein | 2018 | 12 | [22] |
| **13.** | Anuga et al. | Determinants of climate smart agriculture (CSA) adoption among smallholder food crop farmers in the Techiman Municipality, Ghana | 2019 | 12 | [23] |
| **14.** | Kadzere | Environmentally smart animal agriculture and integrated advisory services ameliorate the negative effects of climate change on production | 2018 | 11 | [24] |
| **15.** | Gangwar et al. | A conceptual framework of agroecological resource management system for climate-smart agriculture | 2019 | 11 | [25] |
| **16.** | Patle et al. | Climate-smart water technologies for sustainable agriculture: A review | 2020 | 11 | [26] |
| **17.** | Raile et al. | Political will and public will for climate-smart agriculture in Senegal: Opportunities for agricultural transformation | 2019 | 9 | [27] |
| **18.** | Jellason et al. | Understanding impacts and barriers to adoption of climate-smart agriculture (CSA) practices in North-Western Nigerian drylands | 2021 | 8 | [28] |
| **19.** | Ghosh | Climate-smart agriculture, productivity and food security in India | 2019 | 7 | [29] |
| **20.** | Zecca | The Use of Internet of Things for the Sustainability of the Agricultural Sector: The Case of Climate Smart Agriculture | 2019 | 5 | [30] |

### 3.2. Visualization of climate smart agriculture topic area using VOSviewer

According to Al Husaeni and Nandiyanto [31], in the VOSviewer application, the minimum number of relationships is set by 2 terms. However, in this study, the minimum number of relationships in the VOSviewer between terms is 3. Therefore, the results obtained are 37 items with a total of 6 clusters. Research related to climate-smart agriculture based on visualization mapping analysis is divided into 6 clusters, namely:

(i) Cluster 1 has 9 items, the 9 items are agriculture practice, agriculture productivity, agriculture sector, building resilience, climatic change, concern, emission, GHG, and incentive (See Figure 2).

(ii) Cluster 2 has 7 items, the 7 items are agriculture development, article, barrier, climate change mitigation, climate variability, farmers' perception, and global climate change (See Figure 3).

(iii) Cluster 3 has 7 items, the 7 items are agriculture organization, application, community, food, resource, solution, and transformation (see Figure 4).

(iv) Cluster 4 has 6 items, the 6 items are global warming, natural resource, problem, situation, soil, and term (See Figure 5).

(v) Cluster 5 has 5 items, the 5 items are adaptation, climate-smart agriculture, determinant, rice production, and water (See Figure 6).

(vi) Cluster 6 has 3 items, the 3 items are climate change impact, detail, and transition (See Figure 7).

Cluster 1 is displayed in red, Cluster 2 is displayed in green, Cluster 3 is displayed in dark blue, Cluster 4 is displayed in yellow, Cluster 5 is displayed in purple, and Cluster 6 is displayed in light blue.

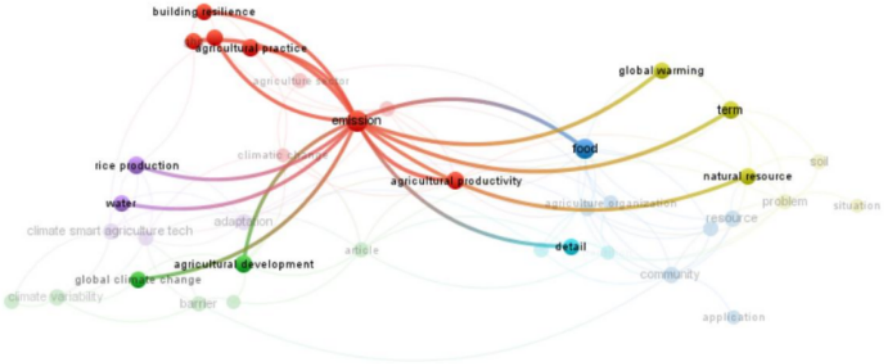


**Figure 2.** Cluster 1 Network visualization of climate-smart agriculture.

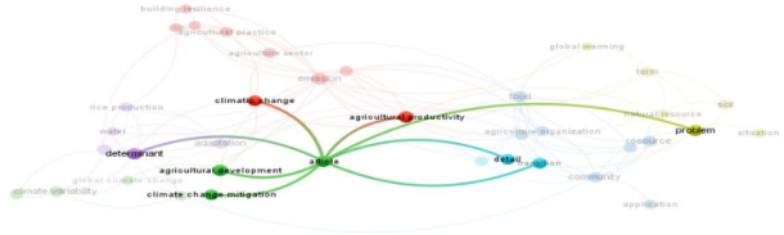


**Figure 3.** Cluster 2 Network visualization of climate-smart agriculture.

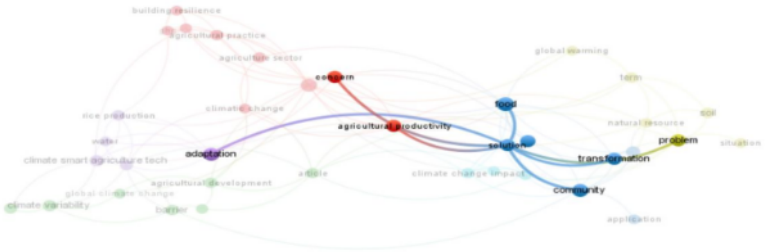


**Figure 4.** Cluster 3 Network visualization of climate-smart agriculture.

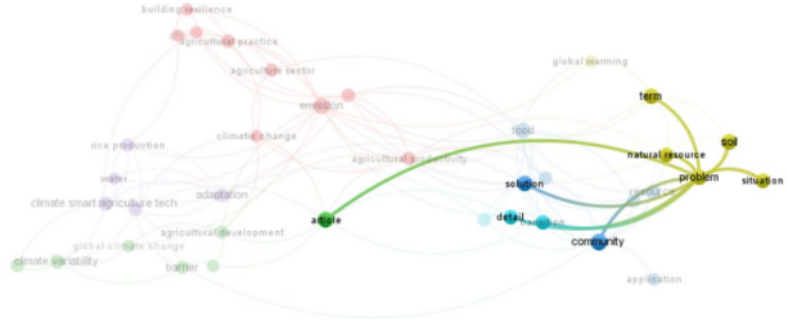


**Figure 5.** Cluster 4 Network visualization of climate-smart agriculture.

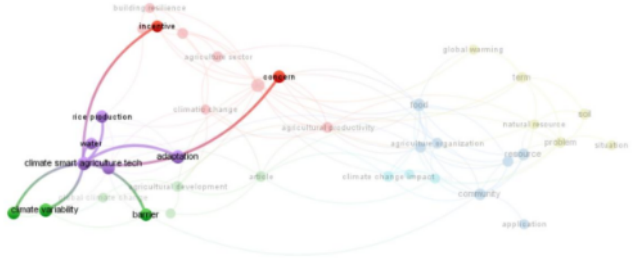


**Figure 6.** Cluster 5 Network visualization of climate-smart agriculture.

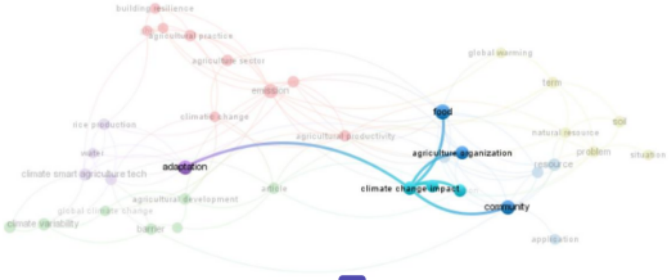


**Figure 7.** Cluster 6 Network visualization of climate-smart agriculture.

### 3.3. Network visualization climate-smart agriculture topic area using VOSviewer

In the VOSviewer application, the mapping of each term is divided into three types, one of which is Network Visualization. Network Visualization describes the relationship between terms on a map. The relationships that exist in the visualization network are depicted in networks or lines that go from one term to another. Figure 8 shows the Network Visualization of the term 'Climate Smart Agriculture' taken from the VOSviewer application. In Figure 8 there is a visualization of each cluster in each of the researched topic areas. As seen in Figure 8, climate-smart agriculture itself is included in cluster 5 with a total strength of 13 and an occurrence of 8. Climate-smart agriculture is connected to cluster 2, namely the term climate variability, and cluster 1, namely the terms incentive and concern.

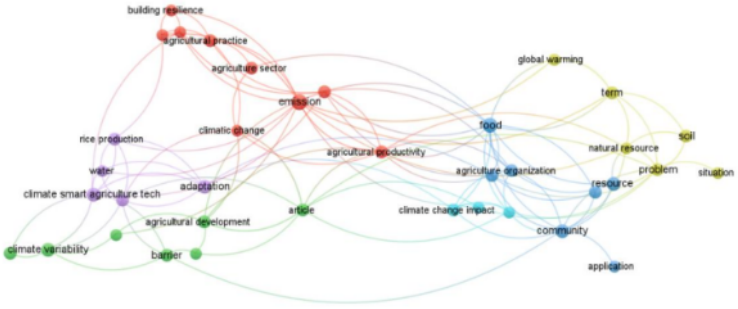


**Figure 8.** Network visualization of climate-smart agriculture.

### 3.4. Overlay visualization climate-smart agriculture topic area using VOSviewer

In addition to Network Visualization, the VOSviewer application also provides a mapping depiction in the form of an overlay. Mapping in the form of Overlay Visualization focuses on the novelty of a term in the research. The novelty of a term in research related to Climate-Smart Agriculture can be seen in Figure 9. In the Overlay Visualization type term mapping, it can be seen how popular a term is from year to year. In Overlay Visualization, different colors indicate the renewal of a term within a certain period. In this study, we use a period from 2017 to 2021. A darker color approaching purple means that research on a term is carried out closer to 2017. Meanwhile, a lighter color approaching yellow is a term that appears in recent research.

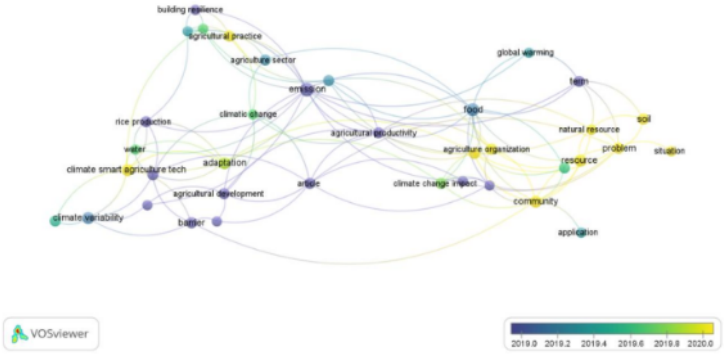


**Figure 9.** Overlay visualization of climate-smart agriculture.

Figure 9 shows an overlay visualization in which climate-smart agriculture is a highly sought-after research keyword following emissions and food. According to Figure 9, climate-smart agriculture is associated with 9 other terms. Terms related to the word climate-smart agriculture include incentive, concern, rice production, water, adaptation, barrier, climate variability, global climate change, and agricultural development. The overlay visualization shows the time the study was updated and the relationship between terms [31].

### 3.5. Density visualization of Climate-Smart Agriculture

The last type of mapping depiction contained in the VOSviewer application is Density Visualization. In this description, each term will be divided according to its popularity in research. Density Visualization of Climate-Smart Agriculture is shown in Figure 10. This type of mapping can be seen from the color that appears in a term. If the color that appears is getting lighter, research on that term is getting more popular or more. Conversely, if the color is getting darker or faded, research on that term is getting less or less frequent. In Figure 10, it can be seen that there are several yellow terms with a fairly large diameter. These terms are emission, climate-smart agriculture tech, food, and resources. This means that these terms are terms that are often used in existing studies. It can be seen in the image in Figure 10 that the density map shows the results of the analysis using all articles on climate-smart agriculture in 2017-2021. The map shows yellow patterns where the yellower the color, the denser the keywords, and the larger the diameter of the circle, meaning that they appear more often and if the colors on the map are fading or blending with the green background, it means that keywords appear less frequently [32-35]. This result also confirms the effectiveness of bibliometric analysis [36-55] to explore and visualize the current literature that can be used for deciding whether further research be done.

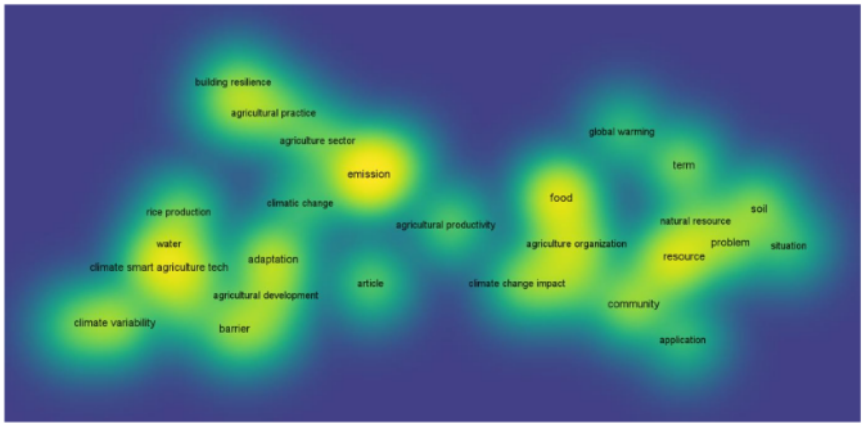


**Figure 10.** Density visualization of climate-smart agriculture.

## Conclusion

This study aims at examining bibliometric literature on climate-smart agriculture. The keyword "climate smart agriculture" was used to obtain the data, which is based on a topic area containing keywords, abstracts, and titles. After we filtered the data, 132 relevant articles were obtained. We used the VOSviewer software to generate the mapping data. The mapping data were generated into network, overlay, and density visualization. Based on the findings of the mapping and analysis using VOSviewer, it was discovered that agricultural research with the term

climate-smart agriculture was the most researched between 2017 and 2021. In this work, we used bibliometrics to identify major themes in each of the previous studies, which is valuable for assessing novelty in future research.

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