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Research Trends in Farming System Soil Chemical: A Bibliometric Analysis using VOSviewer

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Abstract

This study was conducted to determine (1) the growth of the number of scientific publications in the field of soil chemical farming systems, (2) the productivity of researchers, (3) the number of publications by field/subject, and (4) a map of the development of publications based on keywords. This research used descriptive quantitative methods with bibliometric analysis. Data collection was carried out by searching through the Google Scholar database with the keywords "farming system soil chemical" with the categories "authors, publication name, article title, keywords in the period 2017–2021 using Publish or Perish 8 software. In addition, VOSviewer software was used to analyze the development maps' publications. The study results show that the growth of scientific publications in the field of soil chemical farming systems shows a decline, and the highest decline occurred in 2021, namely as many as 21 documents (2.1%). In conclusion, the most publications published in 2017 were 420 publications (40.8%). The subjects with the most studies were soil, system, chemical, production, studies, farmers, and agriculture. The connections between topics are grouped into ten clusters, as seen through network visualization. This research is expected to assist researchers in determining the theme to be studied and can also be a reference for research on soil chemistry.

Keywords: *Farming system soil chemical. Publish or perish, VOSviewer,*

1. Introduction

The farming system is an alternative that plays a role in crop control [1]. Environmental issues associated with agricultural intensification have transformed conventional agriculture into an organic farming system, which can reduce biodiversity in agriculture while increasing food production. Chemical elements in soil vary greatly across space, particularly in agricultural areas [2]. Soil is a natural resource created from layers or horizons of integrated minerals or organic elements with a thickness level that varies in physical and chemical properties [3]. Soil is an important nutrient in food growth, especially in our daily food [4]. In particular, the soil that will be used in carrying out the agricultural process must have good content in the process, one of which is C-organic, which plays an important role in markers of soil fertility, maintaining nutrient readiness, improving soil properties, and maintaining the life of soil microorganisms to get good quality results [5]. To continue further research cases, mapping-based analysis is needed to get a definite value from the research object. A bibliometric mapping-based application appeared, namely VOSviewer. VOSviewer is software that draws scientific maps in various fields with the principle of joint citation [6]. VOSviwer software can quickly analyze data by processing complex data and can display cluster nets with good results [7]. Bibliometrics is a statistical method that uses qualitative methods and can be analyzed quantitatively alongside a specific theme mathematically [8]. One of the themes that must be analyzed is soil chemistry, a branch of science that studies the content contained in the soil. Several researchers have studied it with the keyword "soil chemistry." One of the researches conducted by Biswas et al. (2010) discussed soil chemical properties under modern and traditional farming systems in Khagrachari [9]. Moreno et al. (2018) discussed issues related to farming systems under different soil moisture conditions [10]. Si, G. et al. (2017) discussed the effects of farming systems on soil physicochemical properties in waterlogged paddy soils [11]. Furthermore, many previous reports have discussed about bibliometric analysis using Vosviewer such as Digital learning [12], Computer science [13], Vocational school [14], High school [15], Covid-19 research [16], Scientific publications [17], Chemical engineering [18], Materials research [19], Special Needs Education [20], Publication of Techno-Economic Education [21], Engine performance [22], Dataset portrays decreasing number of scientific publications [23], Application in robotic hand systems [24], Research effectiveness in a subject area among top class universities [25], Educational Research [26], Management bioenergy [27], Magnetite Nanoparticle [28], Nanocrystalline Cellulose Production Research [29], Nano Metal-Organic Frameworks Synthesis [30], Titanium Dioxide Nanoparticle Synthesis [31], Nanocrystalline Cellulose [32], Carbon Nanotubes [33] and Nano-Sized Agricultural Waste Brake Pads [34]. However, there has been no research on farming system soil chemical bibliometric analysis from 2017 to 2019 using VOSviewer. Therefore, this study was conducted to determine (1) the growth of the number of scientific publications in the field of soil chemical farming systems, (2) the productivity of researchers, (3) the number of publications by field/subject, and (4) a map of the development of publications based on keywords and titles in various countries. This research used descriptive quantitative methods with bibliometric analysis.

2. Methods

This study used descriptive quantitative methods with bibliometric analysis to analyze and map research development related to soil chemical farming systems. The data in this study were taken from the Google Scholar database (https://scholar.google.com/). Data collection in this study was carried out by 1) determining the keyword "soil chemical farming system" with the categories of article titles, abstracts, and keywords in the 2017 to 2021 period, which were used to search for documents in Publish or Perish 8, namely articles that were indexed by Google Scholar. Based on the keyword, the initial search on publish and perish yielded 983 documents out of 1000. 2) Data in the form of the number of publications per year in journals containing instrumentation-related articles, authors, and subjects

were saved in the formats (*.ris) and (*.crv). Meanwhile, we used Microsoft Excel 2019 and VOSViewer software to analyze the data. Microsoft Excel 2019 was used to analyze the data based on the year of publication, the number of citations, the methodological approach, and the method used. Meanwhile, VOSViewer was used to analyze and visualize the trend of publication development based on the analysis of frequently appearing article authors, keywords, and publisher journals.

3. Results and Discussion

Table 1. The 15 Top of Citations on Farming System Soil Chemical Publication.

No	Cites	Authors	Title	Year	Source	Ref
1	830	Ali et al.	Environmental chemistry and ecotoxicology of hazardous heavy metals: environmental persistence, toxicity, and bioaccumulation	2019	Journal of chemistry	[35]
2	437	Compant et al.	A review on the plant microbiome: ecology, functions, and emerging trends in microbial application	2019	Journal of advanced research	[36]
3	379	Kung et al.	Silage review: Interpretation of chemical, microbial, and organoleptic components of silages	2018	Journal of dairy Science	[37]
4	282	Blöschl et al.	Twenty-three unsolved problems in hydrology (UPH)–a community perspective	2019	Hydrologica sciences journal	[38]
5	277	Banerjee et al.	Agricultural intensification reduces microbial network complexity and the abundance of keystone taxa in roots	2019	The ISME journal	[39]
6	246	Raliya et al.	Nanofertilizer for precision and sustainable agriculture: current state and future perspectives	2017	Journal of Agricultural and Food Chemistry	[40]
7	214	Yu et al.	Biochar amendment improves crop production in problem soils: A review	2019	Journal of environmental management	[41]
8	211	Kumar et al.	Nano-based smart pesticide formulations: Emerging opportunities for agriculture	2019	Journal of Controlled Release	[42]
9	178	Steffan et al.	The effect of soil on human health: an overview	2018	European journal of soil science	[43]
10	176	Chowdhury et al.	Key sustainability challenges for the global phosphorus resource, their implications for global food security, and options for mitigation	2017	Journal of Cleaner Production	[44]
11	176	Mahmood et al.	Effects of organic and inorganic manures on maize and their residual impact on soil physico-chemical properties	2017	Journal of soil science and plant nutrition	[45]
12	175	Kyul et al.	Influence of anthropogenic activity on transformation of landscapes by natural hazards	2017	Indian journal of ecology	[46]
13	175	Noulas et al.	Zinc in soils, water and food crops	2018	Journal of Trace Elements in Medicine and Biology	[47]
14	163	Paolini et al.	Environmental impact of biogas: A short review of current knowledge	2018	Journal of Environmental Science and Health	[48]
15	151	Morris et al.	Strengths and limitations of nitrogen rate recommendations for corn and opportunities for improvement	2018	Agronomy Journal	[49]

Several data that met the research criteria were gathered through published papers' database search. Data searching utilizing the "publish or perish" reference manager tool showed that 983 data papers fit the research requirements. Several article data sets were collected, including author, citation, year, title, publisher, source article, URL, GSRank, citation URL query date, DOI, type, ISSN, publication, citation, start page, volume, ECC, number of authors, excerpt per author, full-text URL, and abstract. Table 1 shows the article data utilized in the mapping research of VOSviewer. The sample data comprised the top 15 farming system soil chemical publications with the highest citations.

3.1. Research development in the field of farming system soil chemical

The finding in this study was the trend of the articles' number published in the Google Scholar database during the period 2017 to 2021. Based on data obtained from the Google Scholar database, 983 articles related to soil chemical farming systems. Over the last five years, there has been a significant decline in the growth of research and development on farming systems and soil chemicals (See Table 2). The highest publication growth development occurred in 2017, reaching 402 publications (40.8%). Meanwhile, the lowest publication growth occurred in 2021, with 21 publications (2.1%). In 2018, 2019, and 2020, the number of publications on farming system soil chemicals declined to 278 (28.2%), 199 (20.2%), and 81 (8.4%) publications.

The declining trend of published research on agricultural system soil chemistry can be ascribed to several factors, including the COVID-19 pandemic in early 2019. In addition, there has been a significant decrease in international collaboration due to the COVID-19 pandemic. As the pandemic spreads, these changes may cause a reduction in non-COVID-19 research and a reduction in international cooperation [50]. More details on the growth of international publications in the farming system soil chemical sector are shown in Figure 1.

Table 2. Average Data for Publication from 2017-2018

Year	Publication	Percentage (%)
2017	402	40,8
2018	278	28,2
2019	199	20,2
2020	83	8,4
2021	21	2,1
Total	983	100

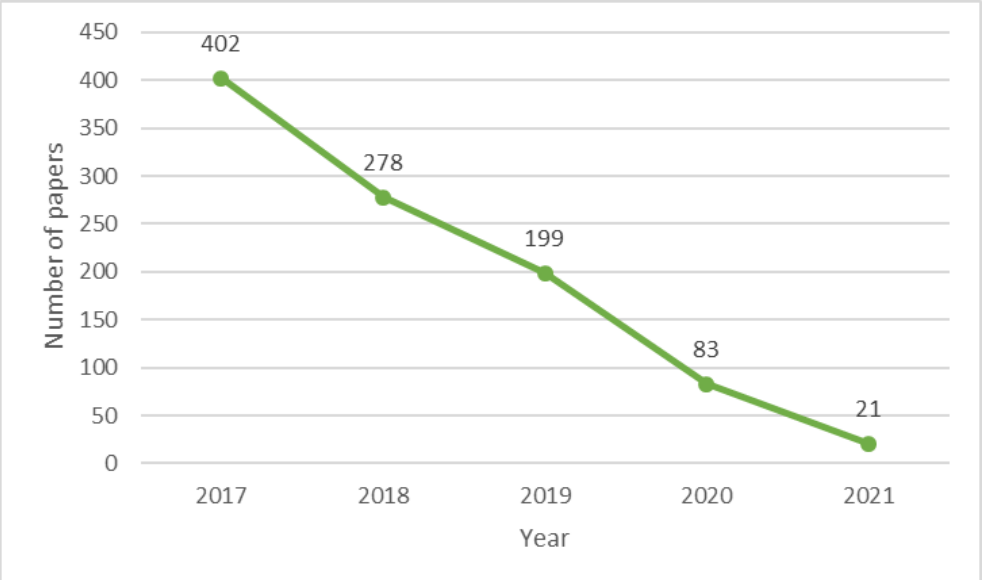

Figure 1. Level of development of research on farming system soil chemical

3.2. Mapping visualization farming system soil chemical topic area using vosviewer

In the visualization, each circle indicates a keyword or phrase that appears frequently, obtained from the title and abstract of the article. The circle size represents the number of articles connected to the word, both in the title and abstract of the article. The larger the circle size, the greater the number of articles related to that phrase or term. The analysis found that 983 articles from the metadata could be classified into ten clusters: six majority clusters and four minority clusters, each of which could be identified based on their color.

(i) Cluster 1 has 55 items, namely abstract, activity, advance, analysis, approach, article, assessment, biodiversity, cab direct, change, chemical groups, chemicals, concentration, conservation, construction, cooky, data, description, detail, diversity, environment, example, greenhouse, heavy metal, heavy metalsheavy metalssubject category, hemiptera, identification, impact, increase, influence, issue, methodology, monitoring, nepal, new species, nov, paper, pattern, physical property, progress, properties, region, relationship, sample, sediment, source, spatial distribution, species, study, subject category, techniques, transformation, treatment, website, and year.

(ii)Cluster 2 has 41 items, namely adoption, agricultural soil, area, benefit, challenge, china, control, country, cover crop, cropping system, development, environmental impact, factor, farm, farmer, farming system, implication, investigation, Kenya, knowledge, majority, management practice, opportunity, perspective, precision agriculture, problem, rate, recent year, research, review, role, seed, soil amendment, soil type, south africa, status, strategy, technology, trend, utilization, and world.

(iii) Cluster 3 has 41 items, namely ability, addition, agricultural system, composition, compost, crop productivity, effect, food, function, indicator, inorganic fertilizer, interaction, maize, manure, microbial community, nutrient, organic amendment, plant, plant growth, present study, process, sandy soil, smallholder farmer, smallholder farming system, soil, soil chemical, soil chemical property, soil fertility, soil helath, soil microbial community, soil nutrient, soil nutrient status, soil ph, soil physico chemical property, soil property, soil quality, soil structure, table, time, transition, and zea.

(iv) Cluster 4 has 37 items, namely adaption, agricultural chemical, agriculture, carbon footprint, chemical, chemical pesticide, climate change, comparison, conservation agriculture, current study, emission, energy, evaluation, farming, fertilizer, human health, importance, integrated farming system, iot, iran, irrigation, life cycle assessment, option, organic farming, organic system, overview, pesticide, production, production system, question, soil carbon sequestration, sustainability, sustainable agriculture, system, use, water, and wheat.

(v) Cluster 5 has 35 items, namely agroforestry system, antioxidant activity, brazil, Cameroon, case study, chemical analysis, chemical fertilizer, chemical input, content, conventional farming, conventional farming system, crop yield, degradation, efficiency, essential oil, experiment, field, forest, heat, land use, long term, order, organic, organic manure, property, reduction, root, soil chemical characteristic, soil organic matter, sustainable farming system, term, tillage, tillage system, winter wheat, and work.

(vi) Cluster 6 has 30 items, namely application, availability, chemical composition, condition, conversion, crop, crop production, crop residue, cultivation, difference, Ethiopia, form, improvement, lignin, lime, nature, nutrient uptake, organic farming system, organic fertilizer, organic matter, part, productivity, research progress, resource, site, structure, area, value, variety, and vermicompost.

(vii) Cluster 7 has 19 items, namely Bangladesh, ee200, growth, Indonesia, land, management, mineralogy, need, potato, quality, rice, soil biology, soil chemistry, stage, systems, tomato, vegetable, yield, and yield component.

(viii) Cluster 8 has 18 items, namely acces, air, characterization, drought stress, email address, India, information, institutional affiliation, legume, location, login credential, my cabi service, name, physico chemical property, relation, response, soil sample, and soybean.

(ix) Cluster 9 has 15 items, namely balance, biorchar, biological activity, biological property, combination, farm system, fertility, fertilization, field experiment, greenhouse gas emission, harvest, level, paddy field, plot, and type.
(x) Cluster 10 has 10 items, namely amount, chemical property, crop rotation, nitrogen, phosphorus, potassium, soc, soil carbon, soil organic carbon, and soil texture.

3.3. Visualization of farming system soil chemical topic using vosviewer

VOSViewer was used in this research to display a bibliometric network of scientific papers connected to farming systems and soil chemicals. VOSViewer creates a network map including keywords, publishing sources, authors, and others [51]. Bibliometric mapping visualizes an area of research by constructing a landscape map that can represent scientific concepts [52]. This program provides the results of bibliometric mapping in three styles of visualization, including network visualization (see Figure 2), overlay visualization, and density visualization (see Figure 3). The map of the visualization results of the smart farming soil chemical co-word network was classified into 301 items, 10 clusters, 10 links each, and a total link strength of 22163. The network map is shown in Figure 2.

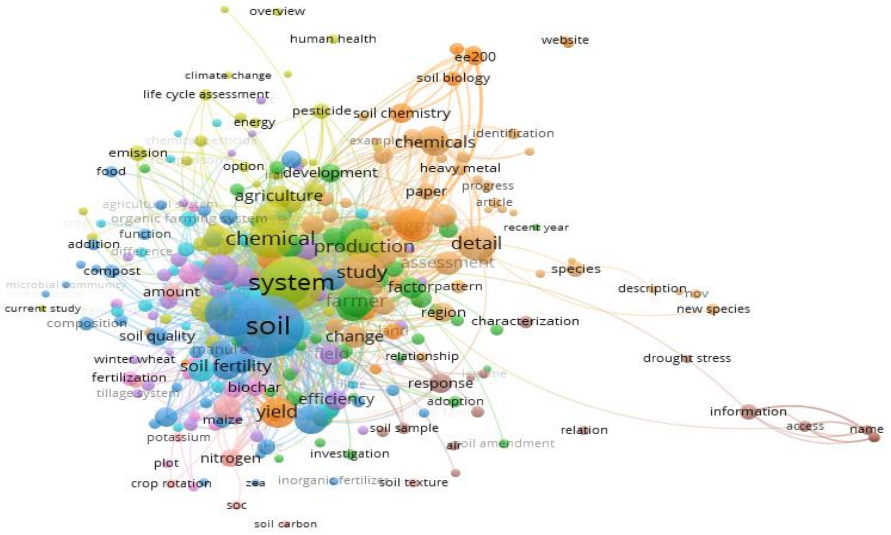

Figure 2. Network visualization of farming system soil chemical system

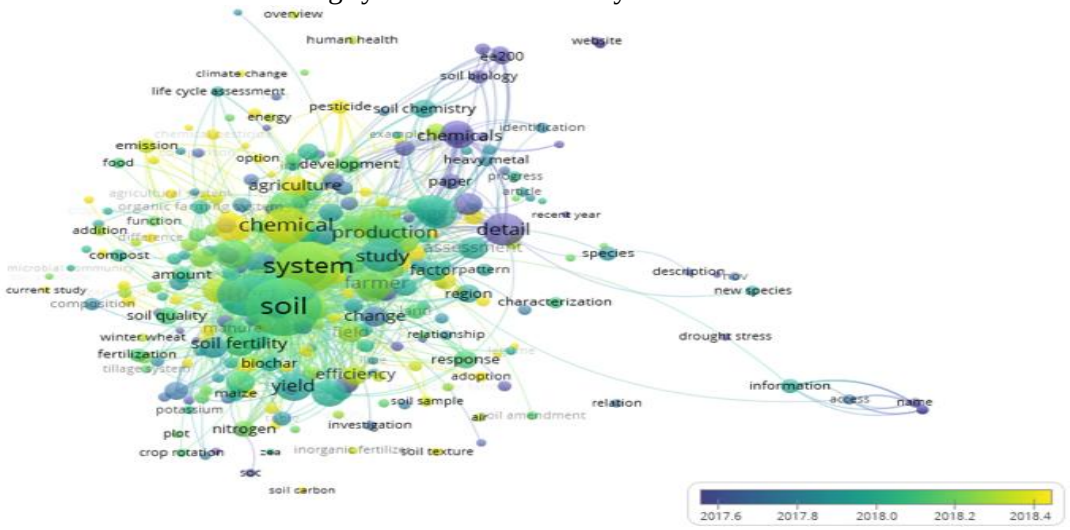

Figure 3. Overlay visualization of farming system soil chemical system

The keywords that are most commonly reflected by the size of the circle are soil, system, chemical, production, study, and agriculture. The least keywords that occur are inorganic fertilizer, soil amendment, and microbial community. It shows that certain keywords are still infrequently mentioned. Therefore, these keywords can be investigated and analyzed further in future studies. To discover the most common study subjects in global research, cluster analysis using the authors' keywords is depicted in Figure 3. Trend topics were illustrated by using overlay network visualization. In overlay visualization networks, the topics or keywords contributing to research are presented by year of publication. The terms "soil and system" were widely studied in 2018 (see Figure 3). Cluster density is an element labeled the same as the display item. Each point has a color that depends on the density of the item. This means that the color of a point on the graph depends on the number of things related to other objects. This section is particularly beneficial for understanding the basic layout of a bibliometric map by identifying which elements are relevant for the study. Throughout this worksheet, we can identify the terms used most commonly in a publication. The depiction of the density map for the growth of co-word research with the theme of farming system soil chemicals is shown in Figure 4.

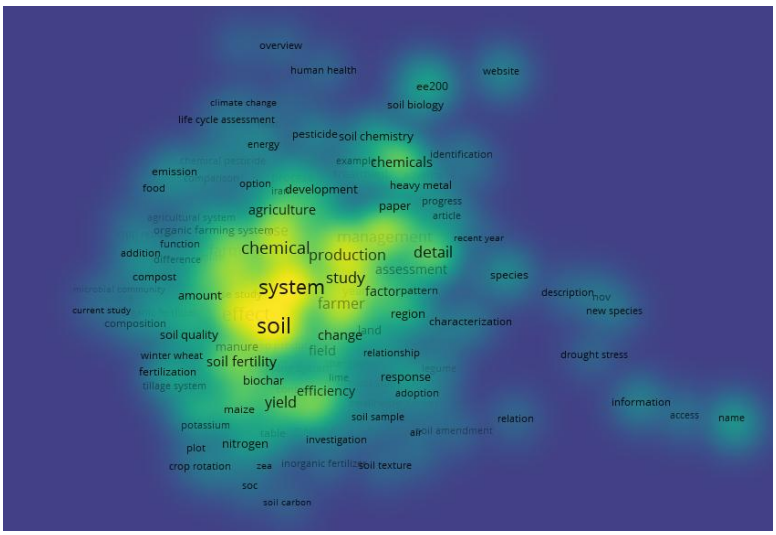

Figure 4. Density visualization of farming system soil chemical system

Figure 4 indicates that the keyword farming system soil chemical has a relatively large density and was covered by numerous additional keywords that encircle it in a close area but far from the keyword soil and system. Some keywords that have become dense have triggered several research interactions that interact with the subject, which shows that the subject is still not thoroughly investigated. Various notions that are part of the growth of multidisciplinary science might become a new gap in research [53]. It is an opportunity for future studies related to farming systems and soil chemicals. Meanwhile, the network visualization on every cluster is shown in Figures 5-14. Cluster 1 is marked with red color with calculations of 206 links, 575 link strengths, and 107 occurrences, and in this cluster, the most research was found with the keyword study. The keyword study is linked to production, system, analysis, soil, chemical, yield, detail, assessment, change, biochar, and species. Cluster 2 is marked green with calculations of 162 links, 400 total link strengths, and 66 occurrences. In this cluster, most research was found on the keyword farm. The keyword farm is linked to agriculture, development, chemical, system, soil, region, factor, management, field, efficiency, and yield.

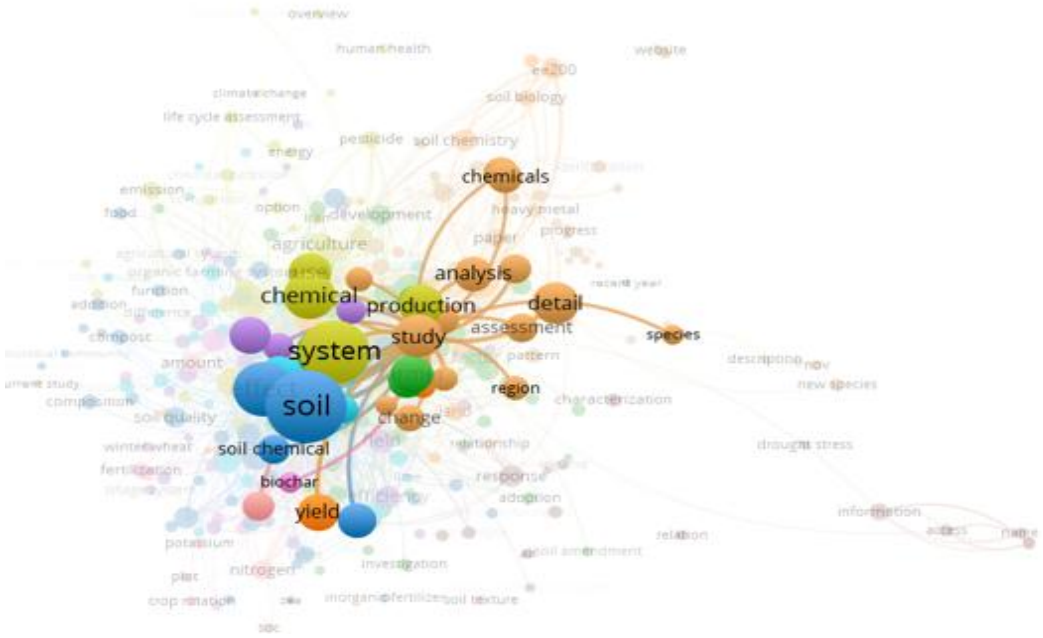

Figure 5. Network visualization of the study term

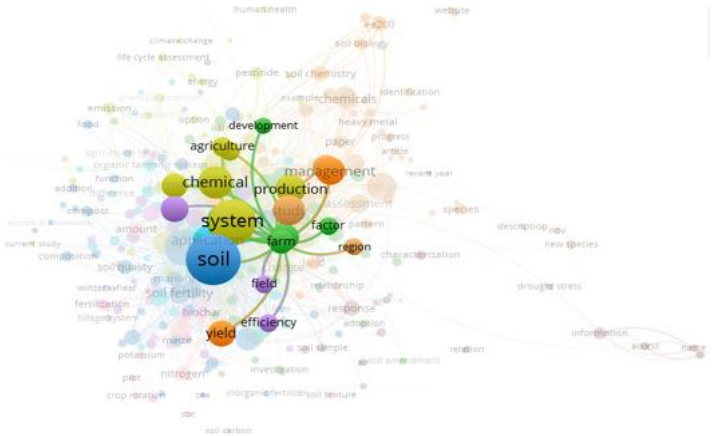

Figure 6. Network visualization of farm term

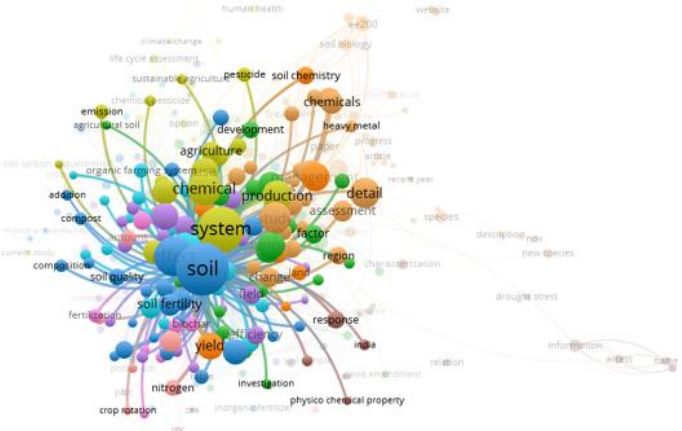

Figure 7. Network visualization of soil term

Cluster 3 is blue and contains 274 links, 2250 total link strengths, and 323 occurrences. In this cluster, most research was found for the keyword soil. The keyword soil is linked to systems, chemicals, production, agriculture, fertility, and others. Cluster 4 is marked with yellow color with calculations of 265 links, 1600 total link strengths, and 248 occurrences, and in this cluster, the most research was found in the keyword system. The keyword system is linked to

production, chemicals, soil, details, factors, and others. Cluster 5 is marked with a purple color with calculations of 176 links, 588 total link strengths, and 81 occurrences. In this cluster, most research was found for the keyword chemical fertilizer. The keyword Chemical fertilizer is linked to soil, soil fertility, production, response, region, and compost

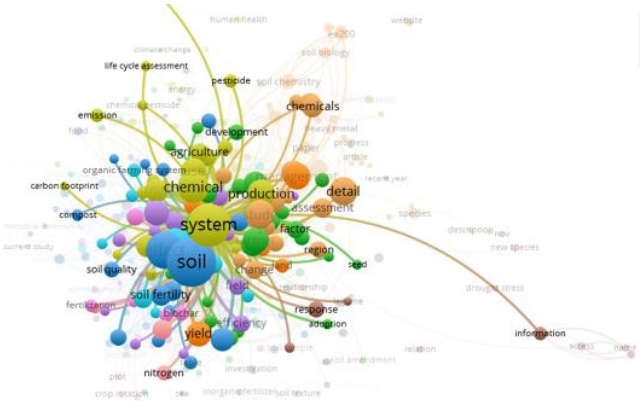

Figure 8. Network visualization of system term

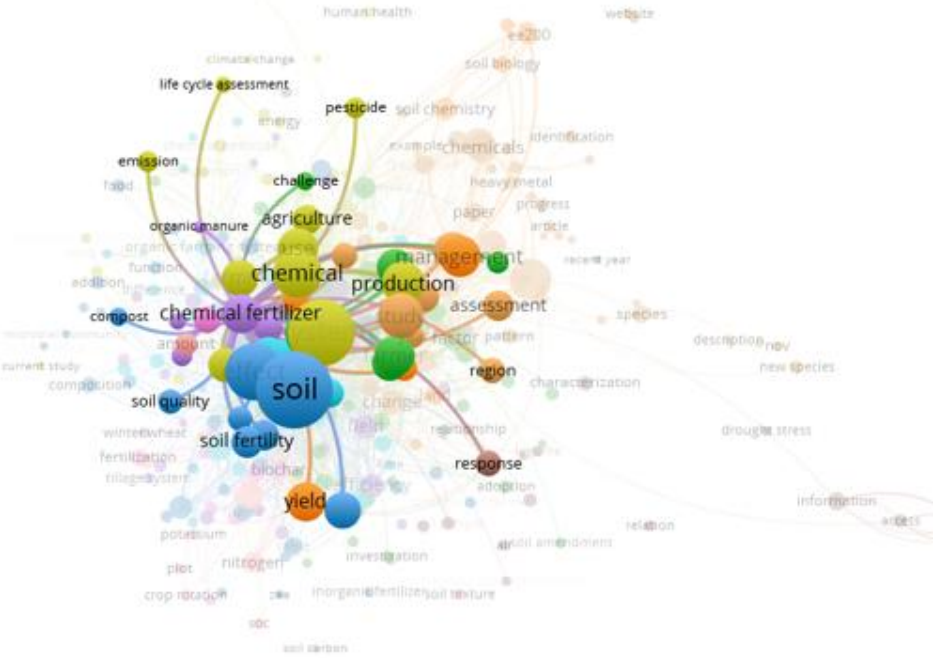

Figure 9. Network visualization of chemical fertilizer term

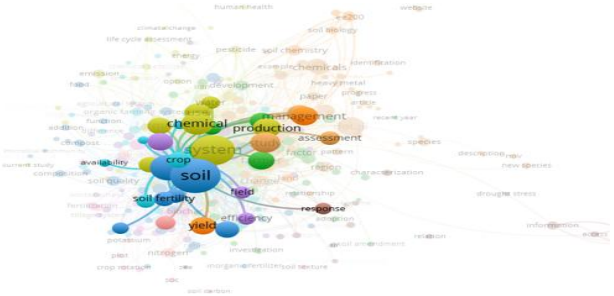

Figure 10. Network visualization of crop term

Cluster 6 is marked with light blue color with calculations of 165 links, 461 total link strengths, and 65 occurrences. In this cluster, most research was found for the keyword crop. The crop keyword is linked to soil, field, crop, soil fertility, yield, production, and chemical.

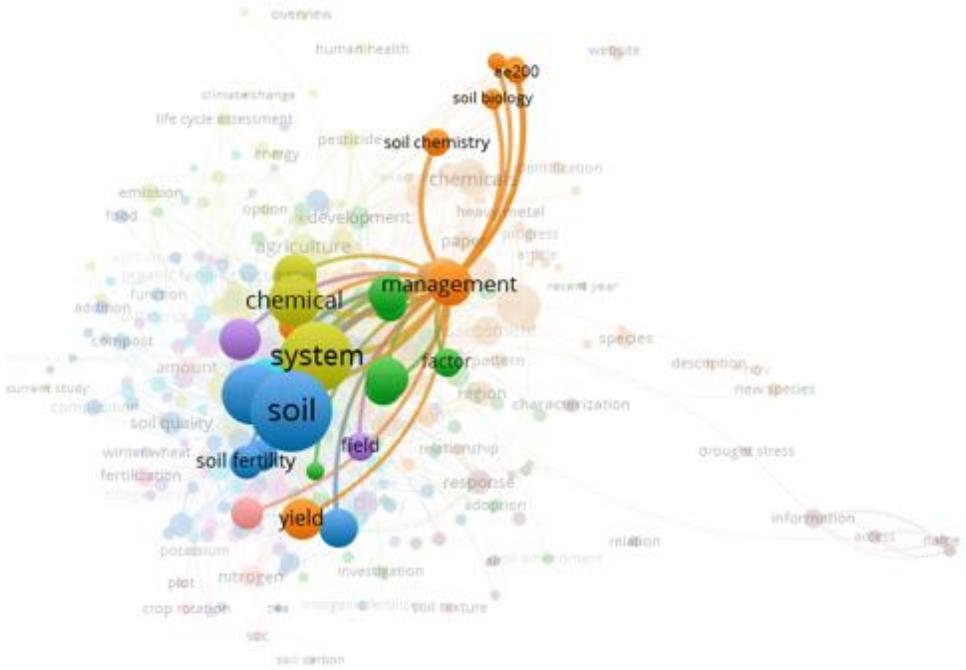

Figure 11. Network visualization of management term

Cluster 7 is marked with an orange color with calculations of 200 links, 627 total link strengths, and 89 occurrences, and in this cluster, the most research was found in keyword management. The keyword management is linked to factor, chemical, system, soil fertilizer, yield, field, soil chemistry, and soil biology.

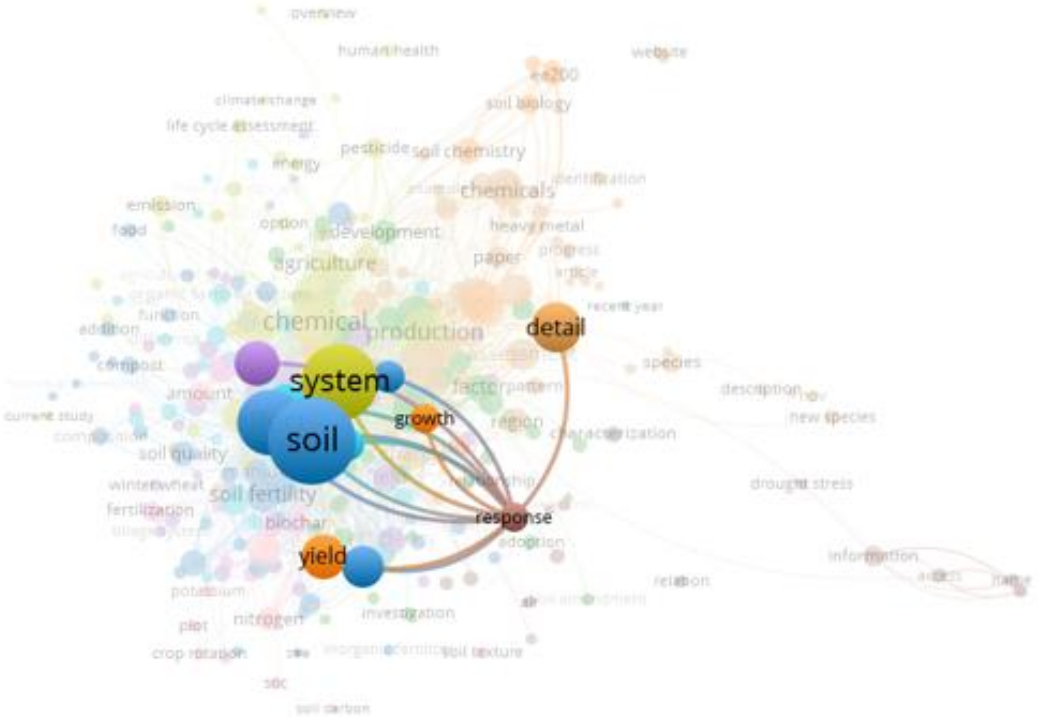

Figure 12. Network visualization of response term

Cluster 8 is marked with a mauve color with 110 links, 221 total link strengths, 107 occurrences, and in this cluster, the most research was found on keyword response. Keyword response is linked to yield, soil, growth, detail, and system.

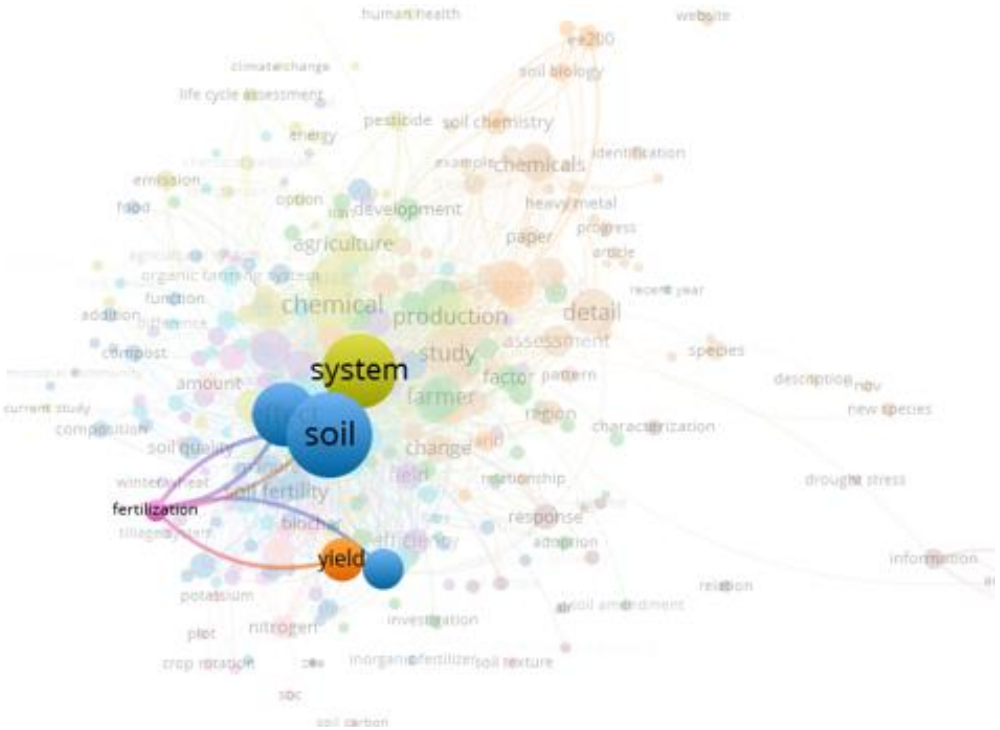

Figure 13. Network visualization of fertilizer term

Cluster 9 is marked with a pink color with calculations of 88 links, 143 total link strengths, 19 occurrences, and in this cluster, the most research was found for keyword fertilizer. The keyword fertilizer is linked to the soil, system, and yield.

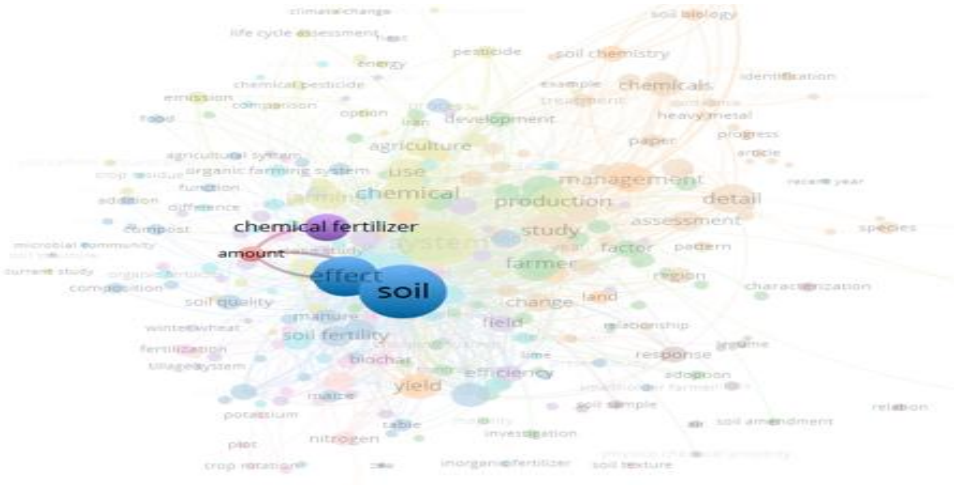

Figure 14. Network visualization of amount term

Cluster 10 is marked with a coral color and has calculations of 97 links, 148 link strengths, and 23 occurrences. In this cluster, most research was found for keyword amount. The keyword amount is associated with chemical fertilizer, effect, and soil. This result also confirms the effectiveness of bibliometric analysis [54-61] to explore and visualize the current literature that can be used for deciding whether further research be done.

Conclusion

Based on the findings, it can be concluded that the development of research on farming system soil chemicals, especially in the journals indexed in Google Scholar by reviewing the literature through the bibliometric method from 2017 to 2021, tends to decrease. Most publications in 2017 reached a total of 402 publications (40.8%). In 2021, the lowest number of publications was 21 (2.1%). The declining trend of published research on agricultural system soil chemistry is due to the Covid-19 pandemic and a lack of international collaboration. This is an opportunity for future researchers to fill in the gaps in literature studies related to soil chemical farming systems, which are well recognized at this moment since agricultural innovation is growing rapidly. This research is expected to assist researchers in determining the theme to be studied and can also be a reference for research on soil chemistry.

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