Regenerative Agriculture Key Traits - Bibliometric Analysis and Quantitative Review

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ABSTRACT

Regenerative agriculture (RA) is an emerging topic that seeks to address the social and economic needs of farmers and their communities while pledging to provide a means of coping with climate change by restoring landscapes. The current study aims to paint a picture of the state of knowledge at this point because the topic keeps sparking academics' interest and the literature grows more extensive. The paper aims to find and present the characteristics of RA and to portray a common understanding of it by combing both quantitative (bibliometric analysis) to be able to include all papers that are mentioning RA and qualitative review (systematic literature reviews) to analyze and extract trends and ideas from the papers focused entirely on RA. The search was conducted in Scopus database and results show that the first paper mentioning RA was published in 1979. A total number of 530 papers were found for the period of 1979-2022 and they were processed using VOSviewer software resulting six clusters. Next, using several exclusion criteria 15 papers were selected for the systematic review. Finally, since there isn't a commonly accepted definition of RA, the study collected the key traits that were mentioned in the literature to paint an outline of it. The main key trait was healthy soil, and it was consistently emphasized when addressing this kind of agriculture.

INTRODUCTION

The primary challenge for society is to produce enough healthy food for a population that is expanding and getting wealthier while staying within the limits of the earth (Willett et al., 2019). Policies such as the EU Circular Economy Action Plan (European Commission, 2015), the Paris Climate Agreement (United Nations, 2015), and the Common Agricultural Policy all recognize the significance of producing food within the planet's carrying capacity. In addition, land degradation and climate change pose significant dangers to farmer wellbeing. For these reasons, it's critical to discover ways to upgrade agricultural systems that will both assist farmers in adjusting to the changes and adhere to United Nations goals. As an effect of the growing concern regarding the effects of agricultural techniques on the environment, researchers have grown more interested in sustainable and regenerative agriculture practices and their benefits over the past several years. In the literature, regenerative agriculture is described as a farming technique that seeks to improve soil health, in-crease biodiversity, and develop landscape resilience by combining farming operations with the environment's natural processes (Newton et al., 2020; Schreefel et al., 2020; Ikerd, 2021; Petcu et al., 2023).

MATERIAL AND METHODS

Since the regenerative agriculture topic gains more and more interest from scholars and the literature becomes richer this paper aims to provide a snapshot of the state of

knowledge at this point. In doing so, the bibliometric analysis as a quantitative method was chosen as it can involve a large amount of data and can provide an overview on the main topics related to regenerative agriculture. While the second analysis was performed more comprehensive using systematic literature review (qualitative method) and was found to be suited for this research as it can bring together and investigate knowledge and extract trends and ideas regarding the focus and the role of regenerative agriculture as perceived by the researchers, specialists, and farmers. Systematic literature review was used to investigate the state of knowledge in different fields. For instance, food security, food waste, and loss in the supply chain (Ewijk and Ros-Tonen, 2021); it was also used to research green innovation, environmental sustainability in local communities, and circular economy activities (Karimi et al., 2021; Kim et al., 2021; Mhatre et al., 2021).

RESULTS AND DISCUSSIONS

This section presents the evolution of variation coefficients calculated on the basis of the methodology presented above.

First stage assessment - bibliometric analysis

Bibliometric analysis was used for quantitative analysis of written publications. Bibliometrics is closely related to the broader term "info-metrics" (Egghe and Rousseau, 1990) and the narrower term "scientometrics" (Bar-Ilan, 2008). A close analogy is "webometrics", which examine various aspects of the web. This type of analysis is based on the identification of the body of literature, i.e. publications in the broadest sense, in a certain field. For the analysis VOSviewer 1.6.19 was employed.

The search was done in the title, abstract, and keywords fields using the search terms "regenerative" and "agriculture" in Scopus database. At this stage no exclusion criteria were used. The timeframe found was from 1979, when the paper was published until 2022. This search resulted in a total of 530 papers.

Bibliometric Study Results

The results were as follows. First papers mentioning the topic was a NASA report published in 1979 (Spurlock and Modell, 1979) that highlighted the necessity of development of closed, regenerating life support systems for space habitats. The areas included agriculture as well. But in 1986 the term of regenerative agriculture was introduced in the paper of Francis et al. (1986) studying the potential of RA, and Kamenetzky and Maybury (1989) focused on the importance of working with nature instead of dominating it. In the following thirty years the trend was constant, until 2018, the year that marked a significantly increasing trend. This was continued in the following years as well (Figure 1).
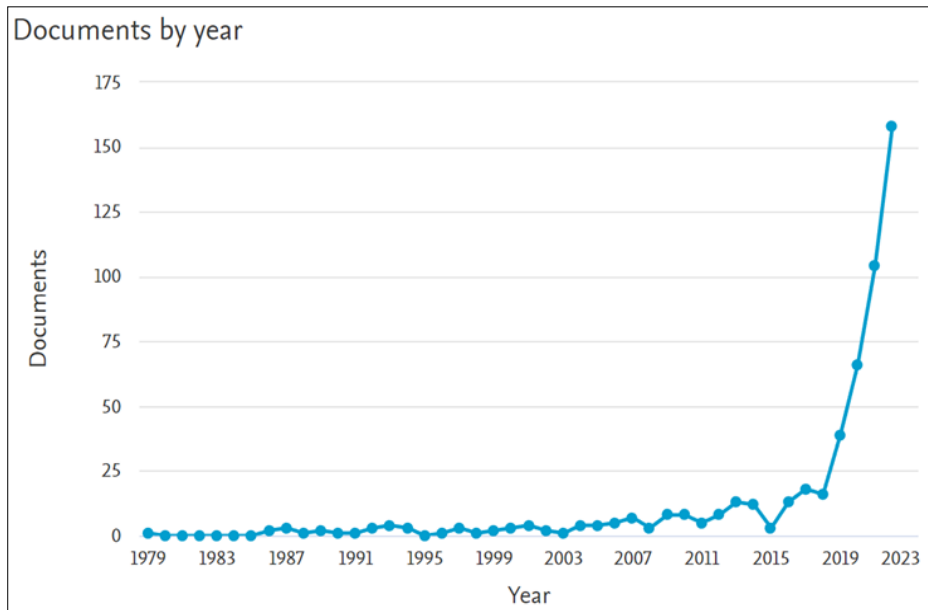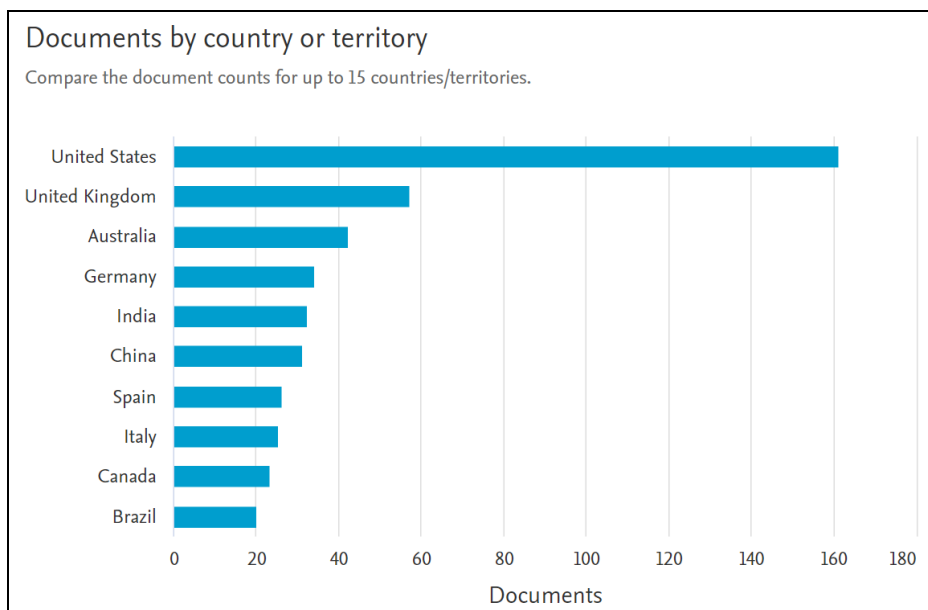
Source: Processed by the authors based on Scopus results.

Figure 1. Research trend

Results also indicate that the United States, the United Kingdom, and Australia, which are developed economies and have high rates of intensive agriculture methods use, have a higher interest in research in regenerative agriculture (Figure 2).

Source: Processed by the authors based on Scopus results.

Figure 2. Documents by country

Next, bibliometric analysis of keywords co-occurrences was performed. Its purpose is to assess keyword correlations and explore these connections to identify prospective study areas. The total number of keywords was 1740 and 38 meet the threshold set to 5 occurrences. The following table shows top 10 keywords, their occurrences and total length strength (Table 1).

Table 1. Top 10 keywords

Keyword	Occurrences	Total length strength
Regenerative agriculture	127	146
Agroecology	27	53
Soil health	26	57
Agriculture	26	28
Biodiversity	23	50
Sustainable agriculture	22	44
Ecosystem services	21	35
Sustainability	17	31
Carbon Sequestration	15	36
Climate change	15	36

Source: Processed by authors using VOSviewer software.

The size of each keyword's node indicated how often the keyword appeared in the documents that were retrieved. An increasing node size indicates a higher frequency of occurrence, and a thick connection line indicated a close connection between two things.
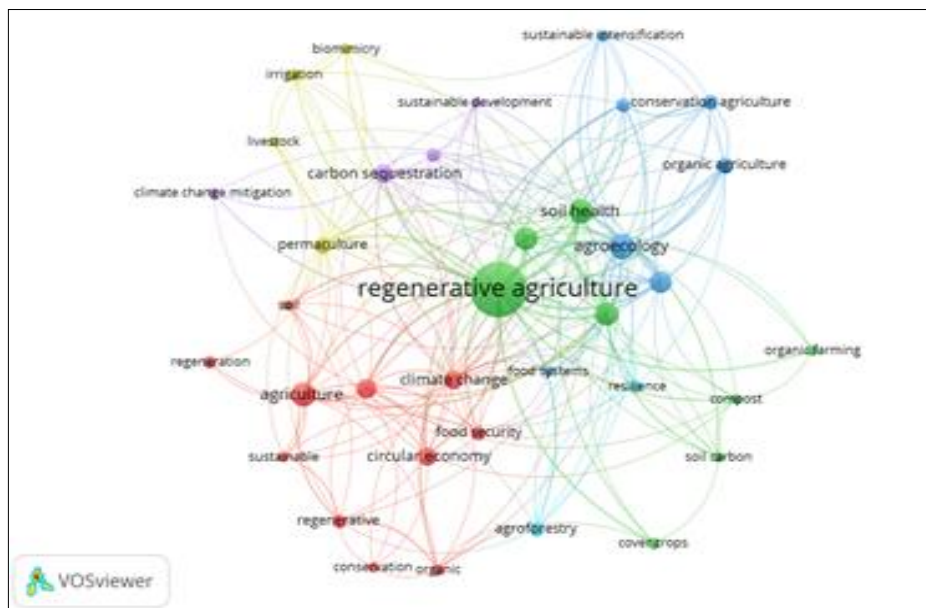
Source: Scopus results processed by the authors using VOSviewer software.

Figure 3. Cluster map of linked words with regenerative agriculture

The map (Figure 3) shows five clusters focused on agroecology (27), soil health (26), agriculture (26), carbon sequestration (15) permaculture (11), agroforestry (8). First cluster highlights the impact on the environment and brings up the following keywords agroecology, ecosystem services, organic and conservation agriculture. As it is known that regenerative agriculture is a nature positive agriculture and has many benefits to the environment.

Second cluster is focused on soil health and highlights the importance of it when considering regenerative practices. Also, biodiversity and sustainable agriculture nodes are part of this cluster.

Third cluster is revolving around the agriculture in the context of climate change, circular economy being focused on the macro scale, globally. This cluster is bringing one of the most discussed topics - climate change

and propose regenerative agriculture as an important vector to overcame it.

More precisely, in fourth cluster the idea is continued by bringing upfront some of the benefits of the regenerative practices, carbon sequestration. In this cluster sustainable development topic and climate change mitigation are also present.

Fifth and sixth clusters contain the lowest occurrences, permaculture and agroforestry and are centered on the natural ecosystems that require a holistic approach.
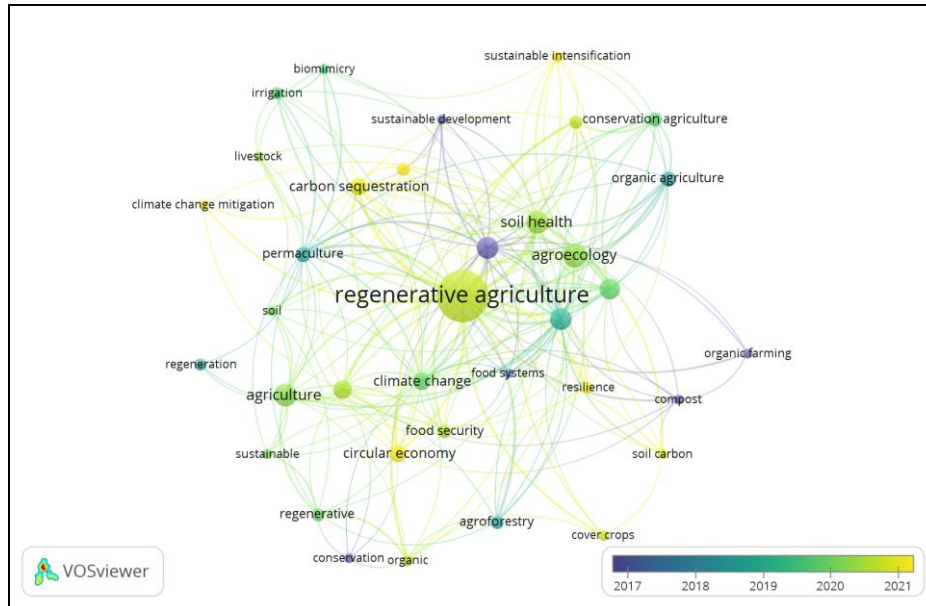
Source: Scopus results processed by the authors using VOSviewer software.

Figure 3. Research core themes dynamics across time

The dynamics over the years (Figure 4) show a non-homogenous trend. In 2017 re-generative agriculture was linked to sustainable development, organic farming, and compost.

While in the next years it was linked to soil health and agroecology and in the end with carbon sequestration, circular economy, resilience, and cover crops. The findings show the importance of soil health characteristics when authors are approaching regenerative agriculture.

Second stage assessment - systematic literature review

For a more in-depth analysis the papers focused entirely on regenerative agriculture were approached using a qualitative method as well.

A systematic review aims to find, evaluate, and summarize research evidence in a methodical manner. It is described as a "technique of identifying, analyzing, and interpreting all the research that is currently available related to a specific research issue or topic of interest" (Grant and Booth, 2009). A three-step methodology from Merli et al. (2018) and Tranfield et al. (2003) was used to conduct the study. Creating the protocol and choosing the study question or topic constitute the first phase. For this paper the research is focused on identifying the role attributed to regenerative agriculture by the scholars. The search process, specifically research selection, extraction, and synthesis, came next. The results interpretation was the last step. Figure 5 shows a graphic representation of the steps.
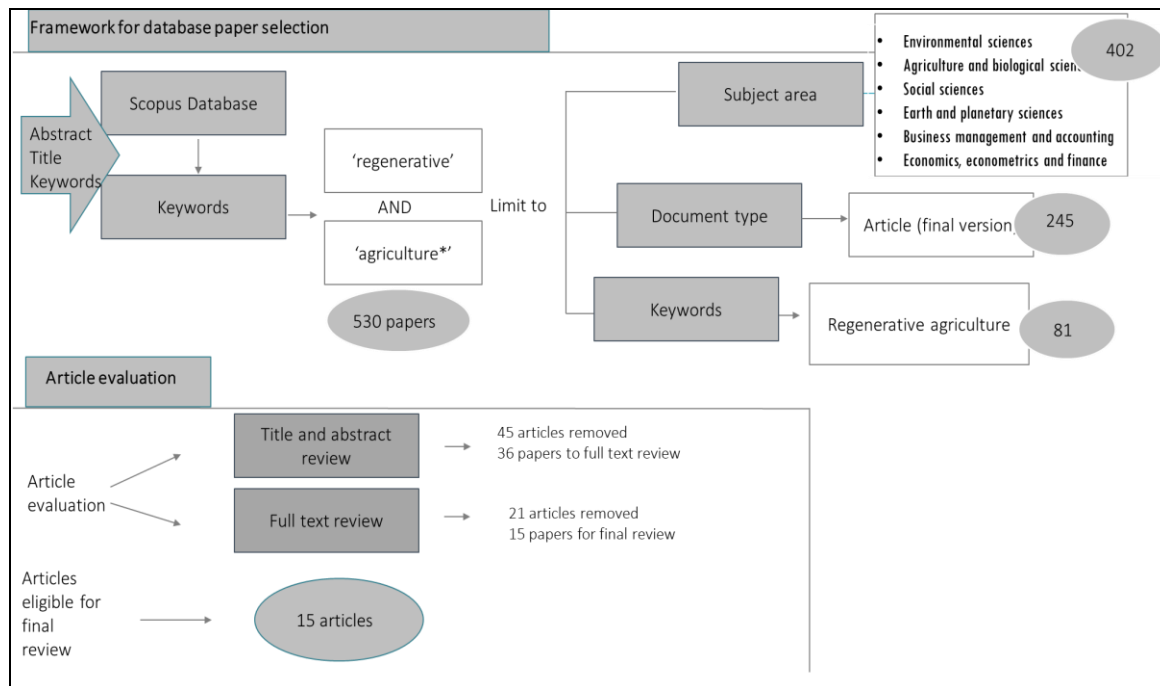
Source: Made by authors based on the methodology.

Figure 5. Steps for identifying the role attributed to regenerative agriculture by the scholars

For this analysis several inclusion and exclusions were performed. The only papers chosen were those that were published in academic journals. Further, the search was restricted to following subject areas: environmental science, agriculture and biological sciences, social sciences, earth and planetary sciences, business management and accounting, economics econometrics and finance. Next, document type chosen was article in final stage, resulting in 81 papers.

Article evaluation was done in two steps, first one was abstract review. After this step, 45 papers were removed as their focus was not within the scope of our research. Further, 36 papers were part of the second step which consisted in full text review. Finally, 15 papers were found to be eligible for our research.

To effectively arrange and compare the information for the final assessment, a form was created to collect the relevant information from the investigated papers, such as paper research method, focus and the role of regenerative agriculture. In order to paint a com-prehensive picture of the definition and role of regenerative agriculture, the study results were analyzed and connected to one another.

Literature Review Results

The topic was approached using several research methods, both quantitative and qualitative. Also, results show that the research interest is higher in the United States, Australia, and United Kingdom. Considering the research trend by year, 2018 marked a significantly increasing trend that it is continued in the following years as well.

Papers from the literature were retrieved and grouped according to their subject and how regenerative agriculture was perceived to give an overview of the scientific interest in the topic.

Regenerative agriculture was found by the authors to be helpful in terms of climate change combat along with advanced technical knowledge. Even though in literature there is no commonly agreed definition of the term of regenerative agriculture, researchers agree that the focus of it is to improve soil condition (Berdeni et al., 2021; Amundson, 2022; Baldwin-Kordick et al., 2022).

Framework | Impact

Research/science:

- the need of a scientific definition for a wider understanding of regenerative agriculture paradigm in literature (Schreefel et al., 2020, Landers et al., 2021, Ateljevic, 2020, Page and Witt, 2022)

- understanding of RA and its benefits to the environment
- commonly agreed scientific definition of RA
- conscious citizens, consumers, producers to advocate for RA changing the way agriculture used to be perceived by integrating the new (technology) with the old (natural cycles of renewal and regeneration)

Macro:

- regenerative agriculture as a method to combat climate change (Dick et al., 2022)
- impact on soil health and function (Baldwin-Kordick et al., 2022, Sherwood & Uphoff, 2000)
- nature-positive agriculture (natural solutions, biomimicry, regenerative agriculture, nature-inspired design); going back to the fundamentals, rediscovering knowledge and skills from our agricultural past or from traditional ways (Amundson, 2022, Sumberg, 2022, Snow, 2020)

- climate change reduction through holistic management; improve soil condition, decrease the need for agricultural inputs and the need of a soil health movement at scientific and education level
- the need to incorporate several fields as progress is sought through mixing digital technology and nature positive agriculture (regenerative practices)

Micro:

- relationship between self-efficacy, regenerative agriculture, and farmer wellbeing (Brown et al., 2022)
- estimate C storage rates in vine woody biomass as an effect of regenerative practices (Williams et al., 2020)
- mapped regenerative and conventional agricultural lands of the US Midwest (Bergmann et al., 2022)
- drivers that motivated farmers in NSW Australia to transition from conventional to regenerative agriculture (Gosnell, 2022)
- focus on soil quality regeneration by grass-clover leys in arable rotations compared to permanent grassland (Berdeni et al., 2021)

- building farming self-efficacy and wellbeing through regenerative agriculture may aid in long-term adaptation to climatic variability
- advancing research in regeneration practices would aid in creating baseline evaluations of ecosystem services in vineyards
- holistic approach by mixing RA techniques with conventional ones to protect the environment and maintain the profitability
- farmers feelings of kinship with nature (animals, plants, and microbes) should be taken more into consideration as drivers of change from conventional to regenerative agriculture
- looking at the soil as a living organism: restoring earthworm population and reverse structural soil degradation could help lowering the risks of flooding and water pollution

Source: Created by authors based on papers review.

Figure 6. Research core themes dynamics across time

When investigating the literature in terms of paper focus, three main clusters were identified as follows: "research", "macro" and "micro" (Figure 6). The research cluster included three papers focused on the broader view of regenerative agriculture and the importance of a common agreed definition at scientific level.

Schreefel et al. (2020) investigated the literature to see how different actors perceived re-generative agriculture and his findings show a lack of a common view agreed at scientific level and emphasized the need of a definition for the term. This view is also backed up by Ateljevic (2020) and Landers et al. (2021) by bringing into discussion the need of conscious consumers, producers and community leaders when referring to nature positive agriculture. Also, Page and Witt (2022) conducted a study to analyse how Australian beef farmers perceived the regenerative agriculture using Q methodology. They found three perspectives regenerative, environmentally conscious, and productive. All three perspectives had in common the following: they want to work with nature and feel connected to their farm and they have no interest in what other farmers are doing or think about their methods.

The next cluster consists in six papers oriented towards the climate change reduction, soil health and nature positive-agriculture and among the proposal, the most common one was the need to integrate several fields to create a holistic approach towards agriculture and mixing the conventional one with the regenerative one.

When considering the investigations focused on planet and environment wellbeing authors raised the issue of climate change and proposed a mix between regenerative and conventional practices as a solution for it (Dick et al., 2022). Also, soil health was the main characteristic considered by some authors as the main issue to be brough into

discussion and they propose a soil health movement among all actors involved (Sherwood and Uphoff, 2000).

Other researchers consider that the mix between technology and different types of nature-positive agriculture as the solution for a healthy planet (Snow, 2020; Sumberg, 2022). Also, they con-sider that nature-positive agriculture should be built on traditions and rediscovering the knowledge and skills from the past.

Final cluster focused on micro level, farm, with practical solutions to protect the environment, seeing the soil as being alive while maintaining farm profitability. More practical solutions were proposed in the papers from the final cluster such as the positive effects of regenerative practices in the farm (Williams et al., 2020), as well as the farmers motivations to incorporate regenerative techniques into their daily activities (Bergmann et al., 2022; Brown et al., 2022; Gosnell, 2022).

CONCLUSIONS

Bibliometric analysis shows that the clusters are not uniform as the topic began to be intensely studied more recently. But, in every cluster there are keywords related to soil health and climate chance mitigation showing how connected are these aspect to regenerative agriculture.

Systematic review showed similar results but highlighting the necessity of a common agreed and comprehensive definition of the RA and adding the importance of merging old knowledge with new technology when practicing regenerative agriculture. Additionally, the systematic review results emphasize how aware of and committed to this type of practice are farmers who engage in RA.

The results of the present study revealed that RA identifies as the type of agriculture that promotes healthy soil as a foundation for the practice of a conscious agriculture combining traditional wisdom with cutting-edge technology and is embedded in farmers lifestyle.

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