

OPTIMIZING AGRICULTURAL YIELDS: EXPLORING ADVANCES IN MICROBIAL CROPS FOR SUSTAINABLE AGRICULTURE

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Abstract

Through this document, it was possible to analyze the main characteristics of the volume of scientific production related to the study of the variables Agriculture, Microbial Crops and Sustainable Agriculture. A bibliometric analysis was proposed to analyze details such as Year of Publication, Country of Origin of the publication, Area of Knowledge in which the published research is carried out, and the Type of Publication most frequently used by the authors of each document published in high-impact journals indexed in the Scopus database during the period between 2018 and 2023 by Latin American institutions. Among the main findings, it was possible to determine that, for the execution of the different research methodologies, the report of 116 scientific documents related to the study of the impact of Agriculture, Microbial Crops and Sustainable Agriculture was achieved. The maximum number of publications made in a year was 31 papers submitted in 2023. The country of origin of the institutions that reported the highest number of records in Scopus was Brazil, with 57 documents. The area of knowledge with the greatest influence at the time of executing the research projects that resulted in scientific publications was Agriculture and Biological Sciences with 59 documents. Finally, the type of publication most frequently used to publicize findings from the analysis of the aforementioned variables was the Article, which represented 57% of the total scientific production.

Keywords: Agriculture, Microbial Crops, Sustainable Agriculture.

1. Introduction

Sustainable agriculture, in the optimization of agricultural yield, implies the conservation and improvement of the productive capacity of the system, whether in the agronomic, environmental, economic and non-renewable resource environments; When we talk about non-renewable resources, we emphasize production systems, soil, water, biodiversity, oil, among others. Among the resources with the greatest relevance in the production processes in sustainable agriculture is the soil, since it is a non-finite renewable resource, it is the main bridge for plant growth, water flow and is responsible for the degradation of harmful environmental compounds. Therefore, soil quality and the application of microbial crops has been a successful strategy that seeks to improve soil quality, as this organic product increases nutrients and restores the functionality of agricultural crops for improved practices

The sustainable development of agriculture is based on the need to be able to improve people's quality of life, use methods to preserve the environment and improve food safety, which is why it is necessary to use biotechnological tools to contribute to sustainable development. This renewable practice seeks to leave behind the traditional methods of agriculture, since it imparts negative effects on the environment, this due to the dependence on fertilizers and chemical fertilizers, which generate greenhouse gases, these gases aggravated food security by not having innocuous production processes and also maximized environmental damage. (López, 2014)

Likewise, sustainable agriculture is based on the need to find a balance between the microbial communities in which they are found; bacteria, fungi, protozoa and viruses, these elements are connected to agricultural crops. These strategies in recent years have had positive effects, as the use of microbial crops related to the

planting of crops has increased, this use helps to mitigate dependence on synthetic fertilizers and with this seeks to reduce the environmental problems caused by dependence on these harmful products. The implementation of these biotechnological tools has yielded positive advances and results in sustainable agriculture, but there are still challenges when it comes to implementing these agricultural systems.(Chávez-Díaz, Zelaya-Molina, Cruz-Cárdenas, Rojas-Anaya, & Ruíz-Ramírez, 2020)

One of the main challenges is related to the economics of the producers, since the economic cost-benefits must be analyzed in a time series; (short, medium and long term), since there is still little information about these production processes and they generate skepticism among consumers, although in this article we explore the benefits of sustainable agriculture and techniques, there is little interest in investment in these production systems since it represents a cost to them as they cannot correspond to the high demand of both national and international markets in terms of productivity and competitiveness; However, if we analyze the long-term benefits, we can see that the balance points to sustainable and long-lasting agriculture, since it takes into account the care of natural resources, such as soil deterioration, self-dependence on harmful fertilizers and new multifunctional services for greater agricultural productivity. For this reason, this article seeks to describe the main characteristics of the compendium of publications indexed in the Scopus database related to the variables Agriculture, Microbial Crops and Sustainable Agriculture, as well. Such as the description of the position of certain authors affiliated with institutions, during the period between 2018-2023.

2. General Objective

To analyze, from a bibliometric approach, the characteristics in the volume of scientific production related to Agriculture, Microbial Crops and Sustainable Agriculture, registered in Scopus during the period 2018-2023 by Latin American institutions.

3. Methodology

This article is carried out through a research with a mixed orientation that combines the quantitative and qualitative method.

On the one hand, a quantitative analysis of the information selected in Scopus is carried out under a bibliometric approach of the scientific production corresponding to the study of Agriculture, Microbial Crops and Sustainable Agriculture. On the other hand, examples of some research works published in the area of study mentioned above are analyzed from a qualitative perspective, based on a bibliographic approach that allows describing the position of different authors on the proposed topic.

It is important to note that the entire search was carried out through Scopus, managing to establish the parameters referenced in *Figure 1*.

3.1 Methodological design

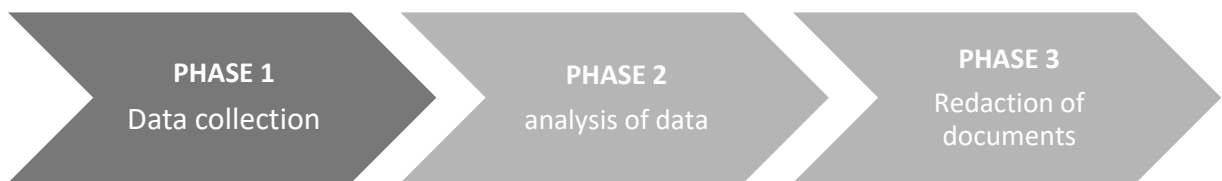


Figure 1. Methodological design

Source: Authors.

3.1.1 Phase 1: Data collection

Data collection was carried out from the Search tool on the Scopus website, where 116 publications were obtained from the following filters:

TITLE-ABS-KEY (agriculture, AND microbial AND crops, AND sustainable AND agriculture) AND PUBYEAR > 2017 AND PUBYEAR < 2024 AND (LIMIT-TO (AFFILCOUNTRY , "Brazil") OR LIMIT-TO (AFFILCOUNTRY , "Mexico") OR LIMIT-TO (AFFILCOUNTRY , "Argentina") OR LIMIT-TO (AFFILCOUNTRY , "Colombia") OR LIMIT-TO (AFFILCOUNTRY , "Chile") OR

above, it is striking that the application of microbial methods in agriculture benefits some of the most important non-finite resources for this work, by applying microbial strains in the soil will help the structuring and establish care in the environment. In addition, in order for agriculture to be sustainable and more friendly to ecosystems, it is important to be aware of the importance of these advances in crop improvement processes and also to raise awareness among farmers to minimize the use of agrochemical applications in crops, since the use of biodegradable inputs increases the efficiency of productivity and therefore they can obtain improvements in crops.

4.2 Distribution of scientific production by year of publication

Figure 3 shows how scientific production is distributed according to the year of publication.

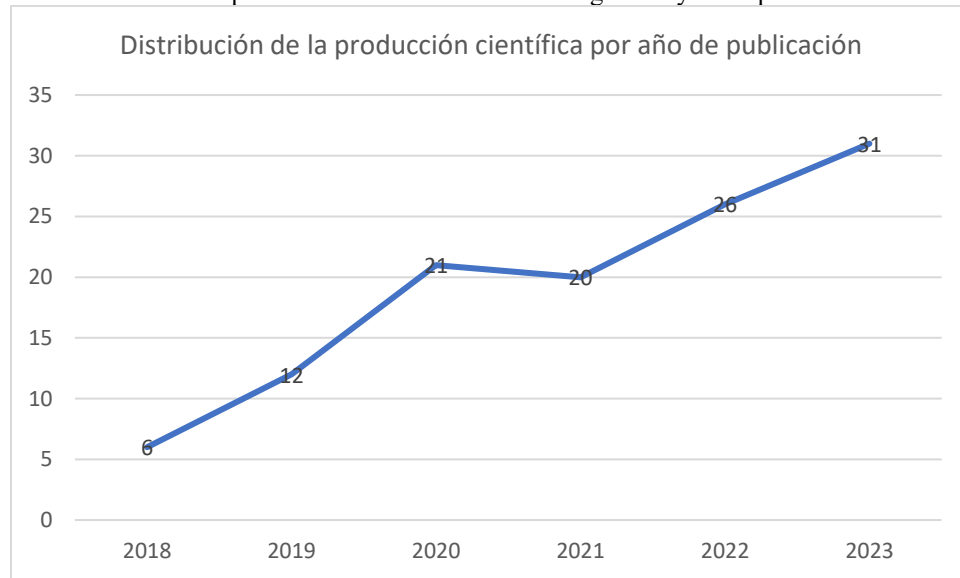


Figure 3. Distribution of scientific production by year of publication.

Source: Authors' own elaboration (2024); based on data exported from Scopus

Among the main characteristics evidenced through the distribution of scientific production by year of publication, an increase in the number of publications registered in Scopus during the years 2023 is noticeable, reaching a total of 31 documents published in journals indexed on this platform. This can be explained thanks to articles such as the one entitled "The coffee-mango association promotes favorable soil conditions for better nourished and higher-yielding plants" This study aimed to compare the physical, chemical and biological characteristics of the soil under coffee production systems: coffee-mango, coffee-banana and full sun coffee; To identify the nutritional variation of the coffee tree in the three cropping systems, and to establish recommendations for the production of coffee associated with other crops. Soil properties varied between shade and full sun systems. The shade-grown coffee systems had different pH, cation exchange capacity, potassium and nitrogen concentrations, organic matter, microbial carbon and nitrogen biomass, and number of earthworms from the full sun coffee system. The coffee-mango association showed specific soil characteristics (exchangeable calcium, moisture, soil porosity and aggregate stability index), foliar (concentrations of calcium, potassium, nitrogen, iron and chlorophyll a and b) and grain (coffee yield, gold, potassium). magnesium and phosphorus) that differentiate it from the other two coffee systems. The coffee-mango system positively influenced soil characteristics, leaf nutrient concentration, yield, yield and nutritional status of the fruit. Coffee production in full sun negatively affects the soil and coffee nutrition and yield.(Romero Fernández, 2023)

4.3 Distribution of scientific production by country of origin.

Figure 4 shows how the scientific production is distributed according to the nationality of the authors.

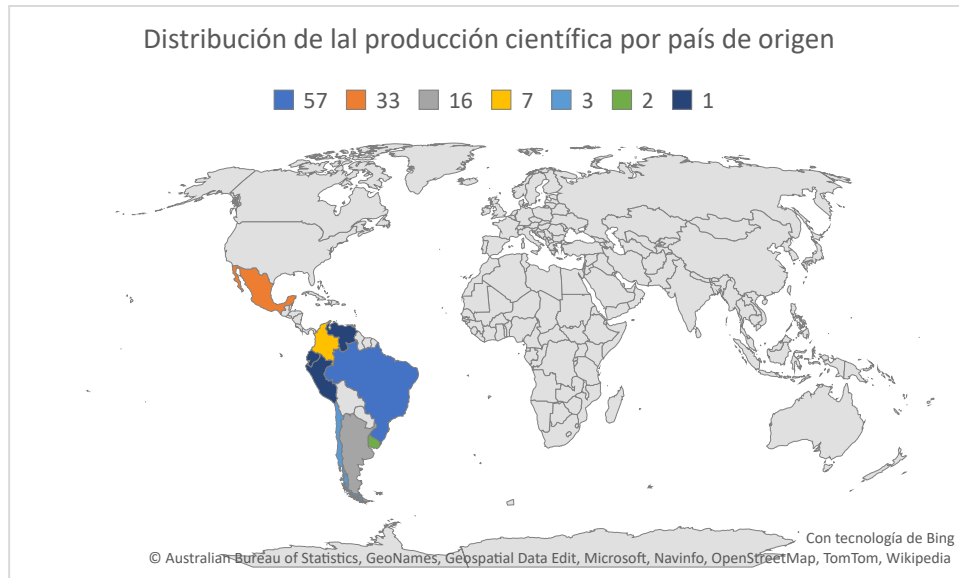


Figure 4. Distribution of scientific production by country of origin.

Source: Authors' own elaboration (2023); based on data provided by Scopus.

Within the distribution of scientific production by country of origin, the registrations from institutions were taken into account, establishing Brazil as the country of this community, with the highest number of publications indexed in Scopus during the period 2018-2023, with a total of 57 publications in total. In second place, Mexico with 33 scientific papers, and Argentina occupying third place presenting to the scientific community, with a total of 16 papers among which is the article entitled "A study of microbial diversity in a biofertilizer consortium" This study examines the composition of the microbiome of a commercial biofertilizer known for its plant growth-promoting activity. Using sequence analysis of the ITS gene and 16S rRNA, we describe the microbial communities of a biofertilizer, with 163 species of fungi and 485 bacterial genera found. Biofertilizer contains a variety of microorganisms that were previously reported to improve nutrient uptake, phytohormone production, stress tolerance, and pathogen resistance in plants. The plants' roots created a microenvironment that boosted bacterial diversity but filtered out fungal communities. In particular, preserving the substrate inoculated with fungi is essential to maintain the diversity of fungi in the root fraction. We describe that the bacteria were more diverse in the rhizosphere than in the substrate. On the other hand, the fungi associated with the roots were less diverse than those associated with the substrate. We propose to use plant roots as bioreactors to sustain dynamic environments that promote the proliferation of microorganisms with biofertilizer potential. The study suggests that bacteria grow near plant roots, while root-associated fungi may be a subset of substrate fungi. (Hernández-Álvarez, 2023)

4.4 Distribution of scientific production by area of knowledge

Figure 5 shows the distribution of the elaboration of scientific publications based on the area of knowledge through which the different research methodologies are implemented.

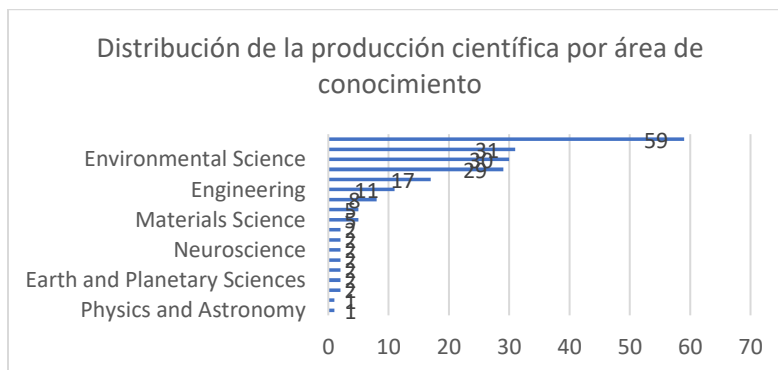


Figure 5. Distribution of scientific production by area of knowledge.

Source: Authors' own elaboration (2023); based on data provided by Scopus.

Agricultural and Biological Sciences was the area of knowledge with the highest number of publications registered in Scopus with a total of 59 documents that have based their methodologies on Agriculture, Microbial Crops and Sustainable Agriculture. In second place, Immunology and Microbiology with 31 articles and Environmental Science in third place with 30. The above can be explained thanks to the contribution and study of different branches, the article with the greatest impact was registered by Agricultural and Biological Sciences entitled "Inoculation with *Azospirillum argentinense* Az19 improves the yield of corn subjected to water deficit in key stages of plant development" This work aimed to compare the performance of *Azospirillum argentinense* strain Az19 with that of the Az39 strain, The most commonly used for commercial inoculants, when inoculated on corn plants exposed to water deficit. To this end, greenhouse and field trials were carried out. In the greenhouse experiment, the Az19 strain avoided the adverse effect of stage V2 water deficit on maize growth. In addition, the percentage of fertile plants and the weight of the ears decreased significantly under the water deficits imposed on V2 and flowering in plants inoculated with Az39, but not in plants inoculated with Az19. In the first field trial with the commercial maize hybrid DOW DS 515 PW, the plants inoculated with Az19 were the ones that best tolerated the imposed water deficit. In the second field trial, two maize genotypes with differential sensitivity to drought (LP 29 × LP 2542, sensitive; LP 882 (923) × LP 4703, tolerant). Greater tolerance to water deficit was detected in plants inoculated with *A. argentinense* Az19, with a notable effect on the components of grain yield in the sensitive genotype. Based on these results, we propose the use of *A. argentinense* Az19 for the formulation of more specific *Azospirillum*-based inoculants, suitable for agroecological areas subject to seasonal water deficits. (García, 2023)

4.5 Type of publication

In the following graph, you will see the distribution of the bibliographic finding according to the type of publication made by each of the authors found in Scopus.



Figure 6. Type of publication.

Fountain: Authors' own elaboration (2023); based on data provided by Scopus.

The type of publication most frequently used by the researchers referenced in the body of this document was the one entitled Journal Article with 57% of the total production identified for analysis, followed by Journal with 26%. Chapter of the Book are part of this classification, representing 13% of the research papers published during the period 2018-2023, in journals indexed in Scopus. In this last category, the one entitled "Soil microbial biomass, N nutrition index and yield of maize grown under eucalyptus shade in integrated crop, livestock and forestry systems" stands out. the N Nutrition Index (NNI) and crop yield. To evaluate the yield in monocultures and integrated crop-forestry, crop-livestock and crop-livestock-forestry systems to propose management strategies for N fertilization in these systems. The systems were established in a 2012 experiment at the Center for Technological Innovation in Agriculture (NITA) under a randomized block design with three replications using crops (corn), livestock (Angus beef cattle) and forestry (eucalyptus). Components. The measurements were made in 2019. The systems showed satisfactory values of CMB and

NMB; however, the agricultural-forestry system had a higher BMC (338.7 mg kg⁻¹) compared to the monoculture system (272.7 mg kg⁻¹). NMB increased by 22% after N fertilization in all systems, and was higher in crop-livestock and crop-livestock-forestry systems probably as a result of urine deposition from N-rich cattle. N fertilization also increased crop yields and NNI in the monoculture system, but not in the crop-forestry system, probably because the trees formed a shady ecosystem that limited plant growth. (Ruthes, 2023)

5. Conclusions

Through the bibliometric analysis carried out in this research work, it was possible to establish that Brazil was the country with the highest number of published records for the variables Agriculture, Microbial Crops and Sustainable Agriculture with a total of 57 publications in the Scopus database. In the same way, it was possible to establish that the application of theories framed in the area of Agricultural and Biological Sciences, the results obtained through the bibliometric analysis indicate that the future of biotechnological tools improves the production processes in agriculture, since it imparts the measures of sustainable development that seeks to care for the environment and still improve production processes. Technological advances for agriculture today have represented several benefits, since it considers that executing innocuous processes at the time of producing food substantially improves health and food safety, cares for and improves non-renewable resources in ecosystems in a more comprehensive and friendly way. It is important to mention that the future of sustainable agriculture lies in the acceptance of microbial strains such as soil and plants, and ensuring the productivity of their crops. However, in order to ensure the use of these microbial strains in sustainable agriculture, the aim is to ensure the profitability of agriculture when implementing these new cultivation techniques, but also to have a positive impact on the care of the environment. This process of advancement in agriculture is obtained through processes of acceptance, training and awareness of new alternative techniques of a beneficial order for crops. This alternative for producers can be evidenced by verifying the effectiveness and purity of using microbial inoculants, which guarantee the quality of the crops and efficiency in increasing production. Most of the benefits of incorporating microbiological products come from the degree of the systems and agriculture, since the characteristics of each microbial strain must be analyzed, which increases the production processes and which crop can favor its applications. According to which it indicates that not every strain or microbial crop works in the same way in all productive or crops, this is due to the fact that the strains have evolved with the natural processes of the plants in certain strictly differentiated habitats, so it is necessary to determine these regulatory specifications for the agroecological factors of each region. (Pérez-Jaramillo, Carrión, & Hollander, 2018)

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