agronomy

Article

Global Trends in Coffee Agronomy Research

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Abstract: This article empirically provides a scientific production trends overview of coffee agronomy at the global level, allowing us to understand the structure of the epistemic community on this topic. The knowledge contributions documented are examined using a bibliometric approach (spatial, productive, and relational) based on data from 1618 records stored in the Web of Science (JCR and ESCI) between 1963 and May 2021, applying traditional bibliometric laws and using VOSviewer for the massive treatment of data and metadata. At the results level, there was an exponential increase in scientific production in the last six decades, with a concentration on only 15 specific journals; the insertion of new investigative peripheral and semiperipheral countries and organizations in worldwide relevance coauthorship networks, an evolution of almost 60 years in relevant thematic issues; and a co-occurring concentration in three large blocks: environmental sustainability of forestry, biological growth variables of coffee, and biotechnology of coffee species; topic blocks that, although in interaction, constitute three specific communities of knowledge production that have been delineated over time.

1. Introduction

This article empirically analyzes the global trends of research in coffee agronomy in terms of its evolution over time, the sources of documentation of scientific production, the geography of knowledge generation (national and organizational), and the topics under study. Research that has been marked by the sustainability agenda in coffee agroforestry has promoted interest in research on organic production systems, the preservation of local cultures and knowledge, biodiversity conservation, and agroecological principles to reconcile sustainable agriculture, considering socioeconomic and cultural contexts that vary at the local level, in order to devise economic development models to further improve the benefits and family budget for family and collective agriculture given its remarketing [1–12]. As a result, socioenvironmental standards and certifications have experienced a strong development in the coffee sector during the last decade [13–17].

Due to the Kyoto Protocol in the face of climate change, coffee agroforestry in general and organic farms have gained increased attention as a strategy for carbon sequestration (C), synergistically conserving biodiversity and reducing greenhouse gas (GHG) emissions [18–23]. Thus, to mitigate global climate change, researchers have proposed new production mechanisms, including studies of flowering phenology, the measurement of

transpiration and water potential in different microclimatic conditions, and the periodic pruning of shade trees to increase the addition of organic matter and the return of nutrients to soil [24–29].

In addition, with increasing patterns of climate variability, water resources for agriculture may become more unpredictable and scarcer [30–33]. For this reason, the presence of shade trees (adequate pruning), the reuse of secondary treated wastewater (with fertilizer management and adequate nutritional conditions), irrigation performance and management (depths and technologies), and groundwater balance seek to reduce soil evaporation and coffee transpiration as measures to preserve water within the agroecosystem [2,34–40].

On the other hand, irrigation systems have become a common technique to improve coffee yields because they provide a more controlled production environment and avoid production losses due to water deficits, this subject being of interest to several researchers [1,2,41–46]. It has been pointed out that soil water deficit is one of the main factors affecting the vegetative development and productivity of coffee, so improving irrigation systems is an important area for researchers to demonstrate its effects [44]. On the other hand, climate change has increased the presence of coffee leaf rust (CLR) (*H. vastatrix*), which is one of the main diseases that strongly affect production [47–49], with an important influence on its costs [50,51]. Given the importance of the management of this disease, it is necessary to have a thorough knowledge of the species and its localities, as the level of incidence and intensity is determined by the microclimates depending on the geographic zones. It is for the same reason that strategies and systems must be designed to predict this disease [52]; however, an important task is to evaluate the pesticide efficiency [53] and determine the tolerance of different coffee genotypes [54]. Thus, drip irrigation techniques can be used to provide nutrients during the growth cycle of the plant based on the plant's nutrient absorption rate, where fertigation improves nutrient use efficiency by gradually providing nutrients and according to their absorption rate [1].

With respect to contaminants in coffee, the use of organic fertilizers and nonselective herbicides (*glyphosate*) has been found to have transitory effects that could result in irreversible and prolonged damage to crop growth and drying conditions (in *Coffea arabica* L.), in addition to Ochratoxin A (OTA), the main mycotoxin found in coffee [55–58]. In terms of pest treatment, the use of yeasts in dual culture with filamentous fungi, the effect of the citrus mealybug *Planococcus citri* (Risso, 1813), and the study of 144 microorganisms previously isolated from the fruit of Coffea arabica to evaluate their proteolytic activities have been discussed [59–61]. There is also the use of shade trees (leguminous and nonleguminous) and organic inputs, particularly in areas where coffee berry disease is prevalent [62]

Scientific studies on coffee agronomy and the effect of micronutrients refer to the application of foliar spraying of Zn sulfate on crops and their yield in Arabian coffee ("Mundo Novo"), obtaining a positive response to increasing concentrations of ZnSO4 applied in oil to the leaves. On the other hand, the use of zinc (Zn) in treatments of acid clay soils in the southeastern region of Brazil had a positive result on soil attributes (chemical fertility, micronutrients, organic matter, and acidity), causing an improvement in pest management and soil recovery [63–66].

Harvesting and subsequent drying are two of the most important operations in coffee production systems, for which the drying technology must be adjusted under different parameters such as mathematical evaluations of the drying curves for different coffee species, thermal losses in the coffee dryer, rotation times, and energy efficiency in a fixed-bed coffee dryer for (*Coffea arabica* L.) [67,68], as well as a continuous rotator and its humidity percentages [69–72].

Finally, the conservation of biodiversity is an important challenge to maintain the richness of native, productive, and mitigation species in agricultural activity, the habitat being a conservation factor of great relevance for the sustainable development of coffee plantations; therefore, the subject is of great interest for several researchers [73–77]. It has been demonstrated that the rural development of geographic areas with population

and production has been adapted to the local environment by following the farming methods and knowledge of the local people, protecting habitats, forestation areas, and the different forms of life in the ecosystem [78]. These landscapes have a relatively high level of agrobiodiversity compared to conventional (monoculture) agriculture [74]. Thus, coffee farms, as habitat fragments, can act as buffer zones and biological corridors between protected forests and other areas [79]. The use of shade trees in agroforestry can also offer an effective coping mechanism to implement in agricultural areas that suffer from extreme climates [25]. This includes crop diversification, coffee marketing activity (e.g., certification of coffee production and postharvest coffee processing), and migrant labor schemes [13,80,81].

2. Materials and Methods

We used a set of articles as a homogeneous basis for citation, counting the main collection of Web of Science (WoS) [82], by selecting articles published in WoS-indexed journals in the Science Citation Index (WoS-SCI), Social Science Citation Index (WoS-SSCI), and Emerging Science Citation Index (WoS-ESCI) based on a search vector [83] about coffee (TS = coffee) restricted to the WoS Agronomy category (WC = agronomy) and with unrestricted time parameters, performing the extraction on 22 May 2021.

The resulting set of articles was analyzed bibliometrically in terms of their exponential growth to ensure a critical mass of documented scientific production that ensures interest in the international scientific community [84,85], determining the time median and its contemporary and obsolete periods. In terms of concentrations, Bradford's law of concentrations was applied to the journals, fragmented into thirds of articles, avoiding the exponential decrease in decreasing performance by expanding the search of references in scientific journals peripheral to the topic under study [86–91]. Lotka's law about authors was applied to identify the most prolific group of authors and study them in isolation from the majority of authors with a smaller number of articles based on the unequally distributed scientific production among authors [92]. The Hirsch index or h-index was used for articles based on the set of articles most cited by the scientific community and the citations they have received in other publications of the WoS core collection, established as the "n" documents cited "n" times or more [93,94]. Zipf's law on words was applied to empirically determine words with the highest frequency of occurrence in the set of articles studied [95]. Information processing and the visualization of spatiality, coauthorship, and cooccurrence [96–99] were processed with VOSviewer, using fragmentation analysis with thematic and time trend visualization outputs [100–108].

3. Results

The results show that there is an exponential growth of documented mainstream research in coffee agronomy between the 1960s and the year 2020, with a scientific production that reached 120 articles in the last recorded year and half-periods of production (median years of publication) located in 2009, as shown in Figure 1. This evidence of compliance with Price's law allows us to consistently give way to other types of bibliometric analysis.
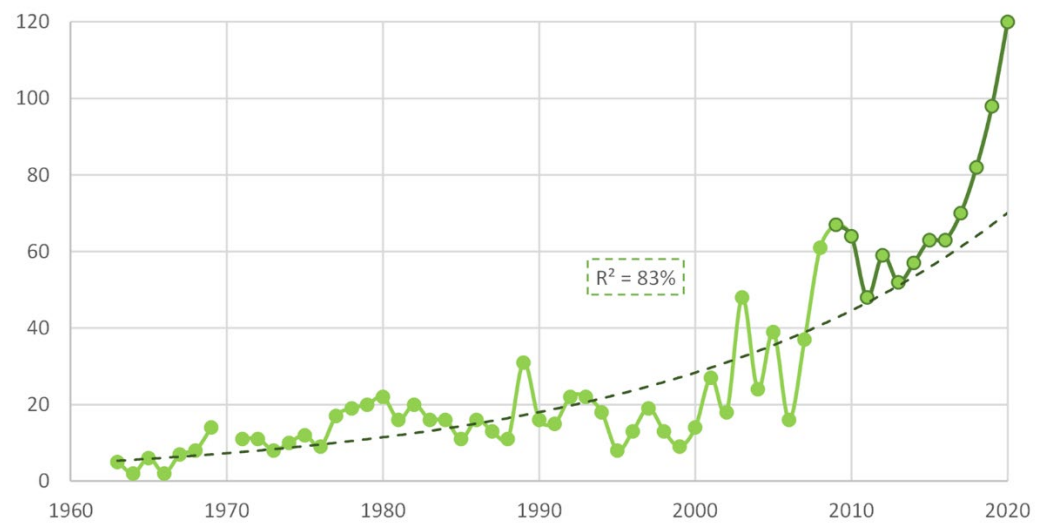
Figure 1. Temporary trend of publications on coffee agronomy (1960s–2020s).

3.1. Scientific Production Environments

The first trend that we identified shows the places or environments of production, including both the bibliographic space of publication sources and the geographic space where this knowledge is generated.

3.1.1. Bibliographic Environments of Scientific Production

In terms of Bradford's law, publications on coffee agronomy between 1963 and 2020 are concentrated in a core of 3 journals out of 125 in total that constitute Bradford's core or main third of article concentration in a small number of journals. In the nucleus zone or first third of articles, 30% are covered, concentrated in three journals; in Zone 2 or the second third of articles, 37% of articles are covered (to complete the 2/3 of articles), concentrated in 12 semiperipheral journals; and finally, Zone 3 or last third covers the remaining articles (34%), dispersed in 110 peripheral journals. As for the Bradford multiplier calculated at 6.6 (average growth rate in the number of journals from one zone to the next), it allows us to calculate the theoretical series of journals that should be found in each zone so that the dispersion of journals is 22.2% lower than the situation we could theoretically have found in Zones 2 and 3, as detailed in Table 1.

Table 1. Publications on coffee agronomy by Bradford's zones between 1963 and 2020.

Zone	Number of Articles in Thirds (%)		Journals (%)		Bradford Multipliers	Journals (Theoretical Serie (S_{SB}))	
Nucleus	482	(30%)	3	(2%)		$3 \times (n^0)$	3
Zone 1	592	(37%)	12	(10%)	4.0	$3 \times (n^1)$	20
Zone 2	544	(34%)	110	(88%)	9.2	$3 \times (n^2)$	130
Total	1618	(100%)	125 *	(100%)	$n = 6.6$		153 *
						% error (ε_p) = −22.2%	

* Real and theoretical value, incorporated for percentage error calculation.

The Bradford zone calculation is reported, as indicated in Table 1. Given a core zone $a = 3$ and a mean multiplier $n = 6.6$, Equation (1) for the geometric series summation of Bradford (S_{SB}) is:

$$S_{SB} = \sum_{i=1}^{3}\left(a * n^{i-1}\right) = 3 + 20 + 130 = 153 \tag{1}$$

with an error percentual margin (ε_p) in Equation (2):

$$\varepsilon_{p=\left(\frac{(Real-Estimated)}{Real}\right)*100=\left(\frac{(125-153)}{125}\right)*100=-22.2\%} \tag{2}$$

Figure 2 shows the evolution of articles published in the 15 journals of the nucleus and Zone 1, in the contemporary half-period from 2009 to 2020, which are mainly published by major worldwide editor companies or by Brazilian institutions (whose characteristics are detailed in Appendix A). As can be seen, the behavior is not homogeneous among the journals, and not all journals show increasing trends.
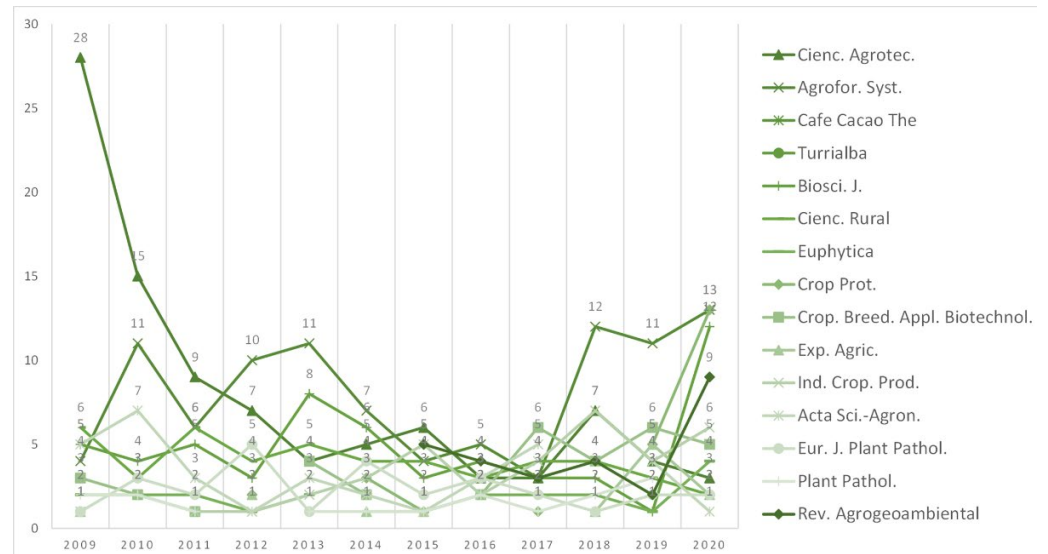

Figure 2. Publications on coffee agronomy in journals from major Bradford zones (2009–2020).

Table 2 below shows that the journals in the WoS core collection (included in the Journal Citation Reports of Clarivate™ version 2020) with an increasing trend of publications on coffee agronomy are Crop Prot. (Q2), Crop. Breed. Appl. Biotechnol. (Q3), Ind. Crop. Prod. (Q1), and Agrogeoambiental Rev. (Emerging Sources Citation Index (ESCI)).

Table 2. Journals from major Bradford zones (1960–2020 and 2009–2020).

Journals	1960–2020	2009–2011	2012–2014	2015–2017	2018–2020	Trends	JIF: JCR-WoS
Cienc. Agrotec.	197	52	16	12	14	↓−	1.390; Q2
Agrofor. Syst.	153	21	28	12	36	→	2.549; Q2
Cafe Cacao The	132	0	0	0	0	0	0; N/A
Turrialba	127	0	0	0	0	0	0; N/A
Biosci. J.	61	14	17	10	16	→	0.347; Q4
Cienc. Rural	57	15	13	11	9	↓−	0.843; Q4
Euphytica	52	6	3	5	7	→	1.895; Q2
Crop. Prot.	45	3	5	2	18	↑+	2.571; Q2
Crop. Breed. Appl. Biotechnol.	43	6	6	8	15	↑+	1.282; Q3
Exp. Agric.	41	1	3	1	8	→	2.118; Q2
Ind. Crop. Prod.	37	2	6	11	17	↑+	5.645; Q1
Acta Sci.-Agron.	36	15	6	9	5	↓−	2.042; Q2
Eur. J. Plant Pathol.	35	6	10	7	5	→	1.907; Q2
Plant Pathol.	31	5	2	4	5	→	2.590; Q2
Rev. Agrogeoambiental	27	0	0	12	15	↑+	ESCI *
Total	1074	179	168	196	300	↑+	—

* Emerging Sources Citation Index, journal without journal impact factor calculation (JIF). N/A: not available, discontinued calculation.

3.1.2. Geographical Environments of Scientific Production

Regarding the geography of knowledge production on coffee agronomy, the set of extracted articles shows 89 countries of authorial affiliation (See Figure 3). Brazil has the largest number of contributions, participating in the coauthorship of 655 articles. Followed at a distance by France (150 articles) and USA (113 articles), all other countries have contributions of less than 100 articles.
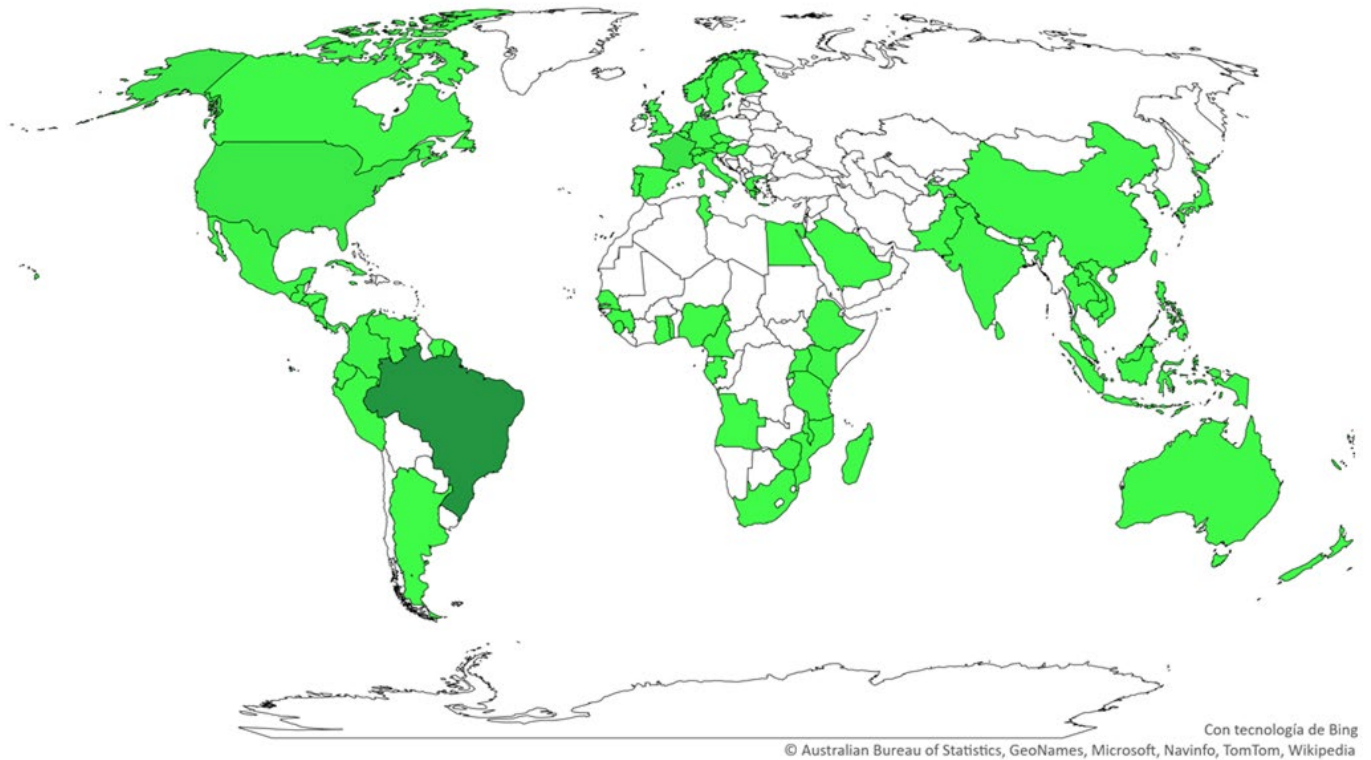

Figure 3. Geography of documented scientific production.

As shown in Figure 4, among these 89 countries, there is a high degree of association between geographically distributed coauthors, although some countries participate in producing knowledge on this topic in isolation: Greece, Hungary, Sierra Leone, Sri Lanka, and Tunisia. The greater width of the lines represents a stronger coauthorship connection between countries and the colors the average number of years of publication; thus, countries with purple nodes have a higher average publication age, and those with a reddish color indicate a lower average publication age.
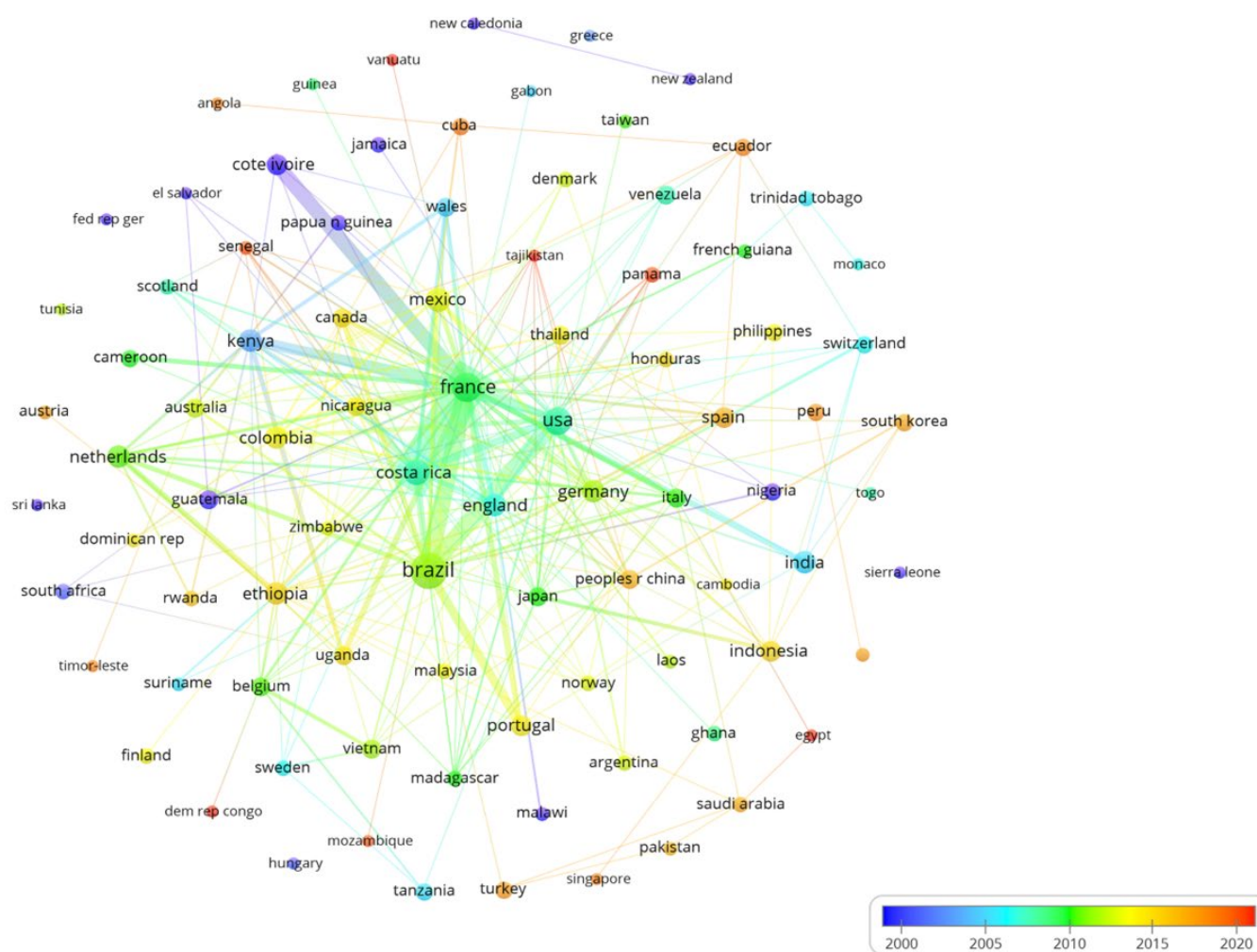
Figure 4. Coffee agronomy research coauthorship network: countries level.

For the graph of coauthorship in Figure 4, the calculation of the "total link strength" was obtained based on the relationships with other countries and the number of joint collaborations using VOSviewer, from which the 14 highest positions are presented in Table 3 (indicator out of 20) and show the best-connected countries within the group of world knowledge production in coffee agronomy. The high contribution of Brazil to the total number of articles is noteworthy (40%), followed at a distance by France (9%). In addition, the articles with contributions from Brazil exceed 4500 citations from other publications indexed in the WoS core collection and the citations received for articles with contributions from France are close to 3000.

Although all the data and metadata analyzed in this article are arranged in English by WoS, this geographical distribution is reflected idiomatically in the articles. In total, 69% of the articles are published in English (contemporary is 77%), followed by articles in Portuguese, French, and Spanish, among others, as shown in Table 4.

Table 3. Relevant countries in coffee agronomy research.

Rank	Country	Published Articles	Contribution at 1618	Citations Received by WoS Core	Total Link Strength
1.	France	150	9%	2898	200
2.	Costa Rica	80	5%	2136	112
3.	Brazil	655	40%	4537	94
4.	USA	113	7%	2378	85
5.	United Kingdom	35	2%	641	42
6.	Kenya	32	2%	392	39
7.	Germany	29	2%	368	36
8.	Mexico	45	3%	670	34
9.	Nicaragua	12	1%	193	31
10.	Netherlands	28	2%	453	30
11.	Ethiopia	27	2%	285	28
12.	Colombia	41	3%	276	27
13.	Canada	11	1%	65	22
14.	Portugal	25	2%	484	20
15.	Japan	16	1%	220	20
16.	Uganda	12	1%	222	20

Table 4. Publication languages in coffee agronomy research.

Language	Articles (1960–2020)	% of 1618	Articles (2009–2020)	% of 846	Avg. Cit. per Article (2009–2020)
English	1120	69%	652	77%	5898/652 = 9.05
Portuguese	269	17%	135	16%	577/135 = 4.27
French	126	8%	21	2%	76/21 = 3.62
Spanish	95	6%	36	4%	32/36 = 0.89
German	3	0%	0	0%	0
Japanese	2	0%	0	0%	0
Indonesian	2	0%	2	0%	1/2 = 0.50
Hungarian	1	0%	0	0%	0
Total	1618	100%	846	100%	6584/846 = 7.78

3.2. Actors of Scientific Production in Coffee Agronomy

Among these actors, we identified authors and their affiliation organizations in search of trends in research on coffee agronomy.

3.2.1. Author Affiliation Organizations Network

To reduce, in terms of relevance, the number of author-affiliated organizations, the Hirsch index or h-index was used, and therefore, only the 52 documents cited 52 times or more (for a resulting h-index of 54 citations) were considered, all published in English (in contrast, 297 articles did not present citations, and there are 191 with only one citation). Thus, the 1242 author-affiliated organizations present in the 1618 articles under study were reduced to 129 organizations. This set of high citation (impact) articles was published between 1986 and 2015, and among the organizations contributing to this production are the Federal University of Lavras (with two affiliations: "univ fed lavras" and "univ fed lavras ufla") and the Federal University of Viçosa ("univ fed vicosa") and most other universities in Brazil. Another highlight is the high average number of citations received by the Tropical Agricultural Research and Teaching Center (CATIE). Table 5 shows the top 10 organizations in terms of coauthorship contributions in published articles and Figure 5 shows the coauthorship network among the 129 organizations.

Table 5. Relevant author affiliation organizations in coffee agronomy research.

Organization	Documents (A)	Citations (B)	Avg. Cit. (C = B/A)	Links	Total Link Strength	Avg. Pub. Year
Univ Fed Lavras (Federal University of Lavras)	172	1113	6	20	87	2011
Univ Fed Vicosa (Federal University of Viçosa)	122	1030	8	22	74	2012
Univ Fed Lavras UFLA (Federal University of Lavras)	99	492	5	12	52	2012
CIRAD [1]	64	855	13	26	78	2012
Univ Sao Paulo (University of Sao Paulo)	53	456	9	22	36	2005
CATIE [2]	43	1410	33	24	61	2012
EPAMIG [3]	29	178	6	8	35	2008
Univ Fed Espirito Santo (Federal University of Espirito Santo)	29	191	7	12	29	2014
Univ Fed Uberlandia (Federal University of Uberlandia)	25	78	3	6	13	2014
Univ Estadual Paulista (Sao Paulo State University)	23	246	11	7	15	2014

[1] Centre de Coopération Internationale en Recherche Agronomique pour le Développement/Center for International Cooperation in Agricultural Research for Development (CIRAD, París and Montpellier, France), [2] Centro Agronómico Tropical de Investigación y Enseñanza/Tropical Agricultural Research and Teaching Center (CATIE, Costa Rica and other countries), and [3] Empresa de Pesquisa Agropecuária de Minas Gerais/Agricultural Research Company of Minas Gerais (EPAMIG, Brasil).
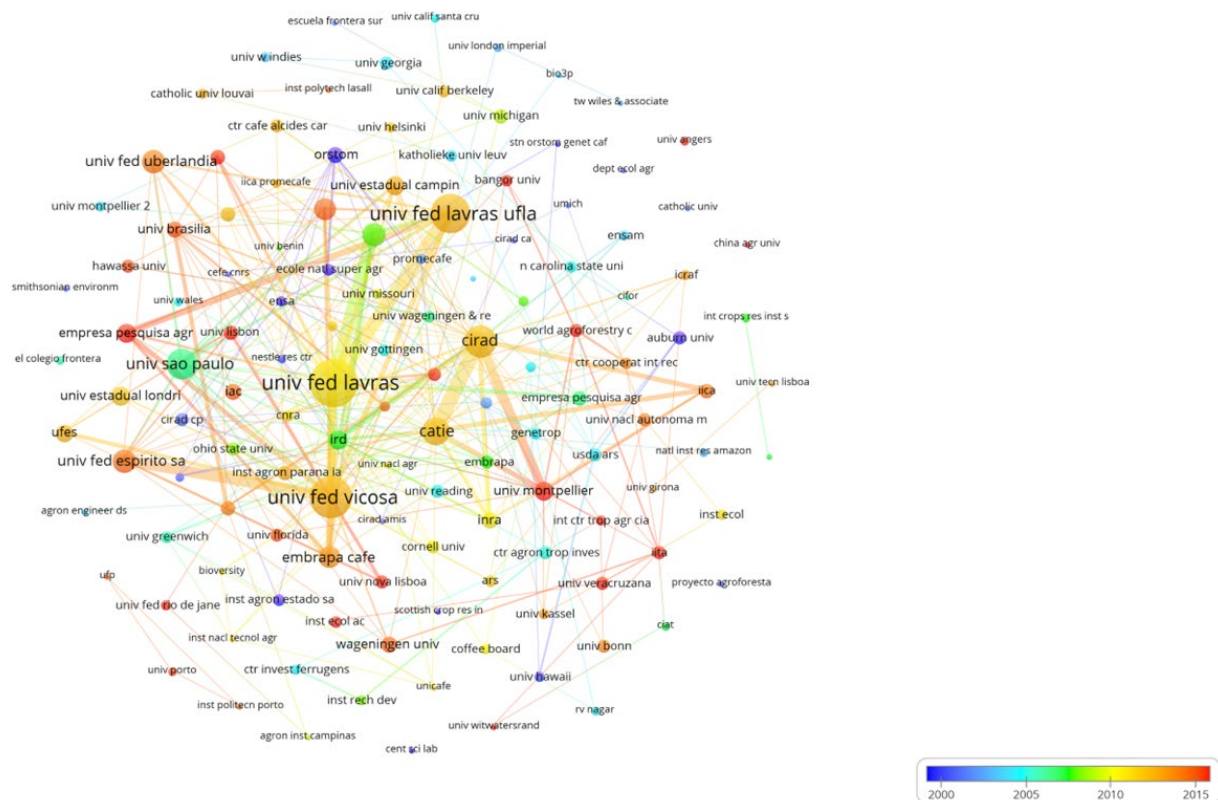

Figure 5. Coffee agronomy research coauthorship network, organizations level.

3.2.2. Prolific Coauthors Network

For the total 4670 authors contributing to the 1618 articles, 68 authors were estimated to be prolific (root square = 4670), and 57 authors with at least 7 publications were chosen, which, as shown in Figure 6, constitute 5 clusters, detailed in Appendix B.
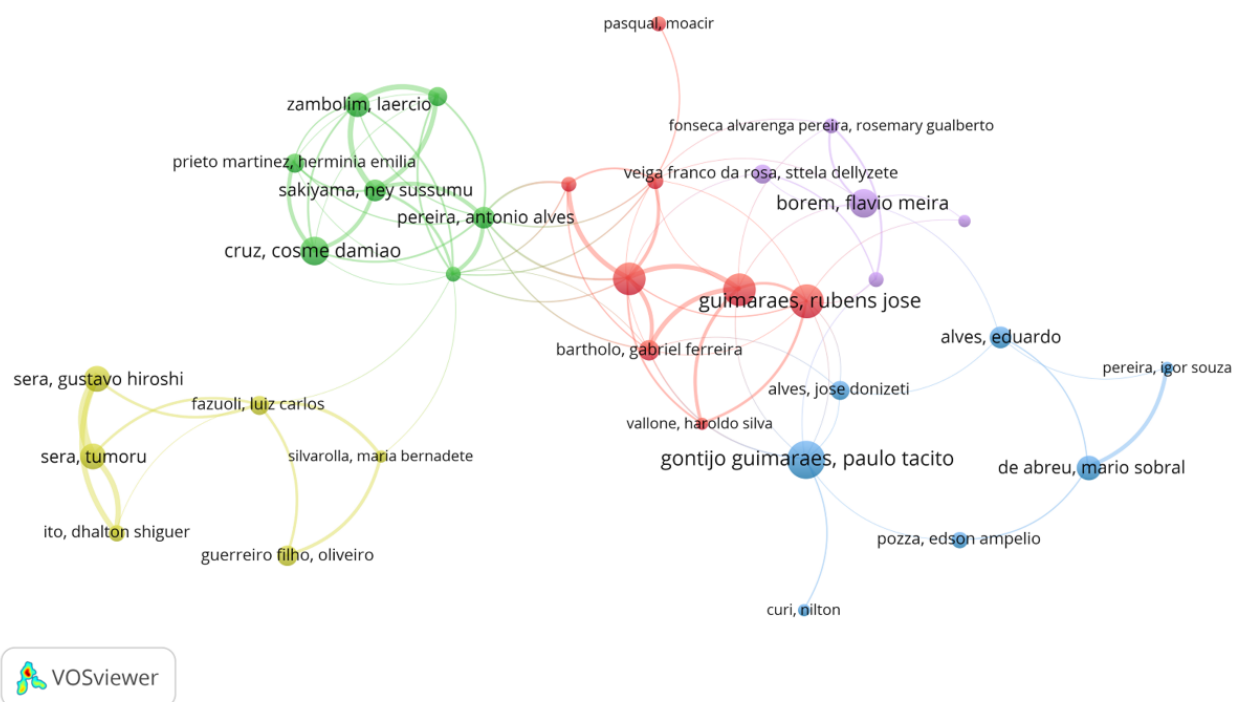

Figure 6. Coffee agronomy research coauthorship network, authors level.

As for the number of publications, Paulo Tácito Gontijo Guimaraes, PhD in Agronomy, with an emphasis in Fertilization and Soil Fertilization, and Coordinator of the Plant and Soil Nutrition Laboratory of EPAMIG Sul (Lavras, Brazil), has conducted research on topics related to the fertilization, quality, and seedlings of coffee. He is the author with the most publications, with 20 articles being cited 128 times in the WoS core collection. A second relevant author identified in this study is Philippe Lashermes, a researcher at the Institut de Recherche pour le Développement (IRD, France) and codirector of the international initiative that sequenced the coffee genome, who, in the present study, records 18 publications and 897 citations in the WoS core collection. Some other relevant authors on this topic are Rubens José Guimaraes (18 publications), Antonio Nazareno Guimaraes Mendes (17 articles), and Gladyston Rodrigues Carvalho (17 articles) (see Table 6).

Table 6. Relevant authors in coffee agronomy research.

	Authors	Articles	Citations	Total Link Strength
1	Paulo Tácito Gontijo Guimaraes	20	128	9
2	Philippe Lashermes	18	897	16
3	Rubens José Guimaraes	18	96	35
4	Antonio Nazareno Guimaraes Mendes	17	82	27
5	Gladyston Rodrigues Carvalho	17	66	36

3.3. Subjects of Scientific Production in Coffee Agronomy

Through text data mining, 5142 keywords were identified (author keywords and keywords plus) and approximately 72 outstanding keywords, 66 being chosen as outstanding

keywords with an occurrence of 15 or more times, which present an average age that covers the last decade. Among the outstanding keywords with a more recent average age, in yellow to red colors, the following concepts stand out: climate change, organic matter, growth, shade trees, etc. (see Figure 7). This tendency to the proliferation of new research topics is inserted within three major research areas that are identified in Figure 8 by establishing fragmented clusters with the relevant keywords: the theme of environmental sustainability in forestry (in green), another with respect to the variables of biological growth of coffee (in blue), and finally oriented towards the biotechnology of coffee species (in red).
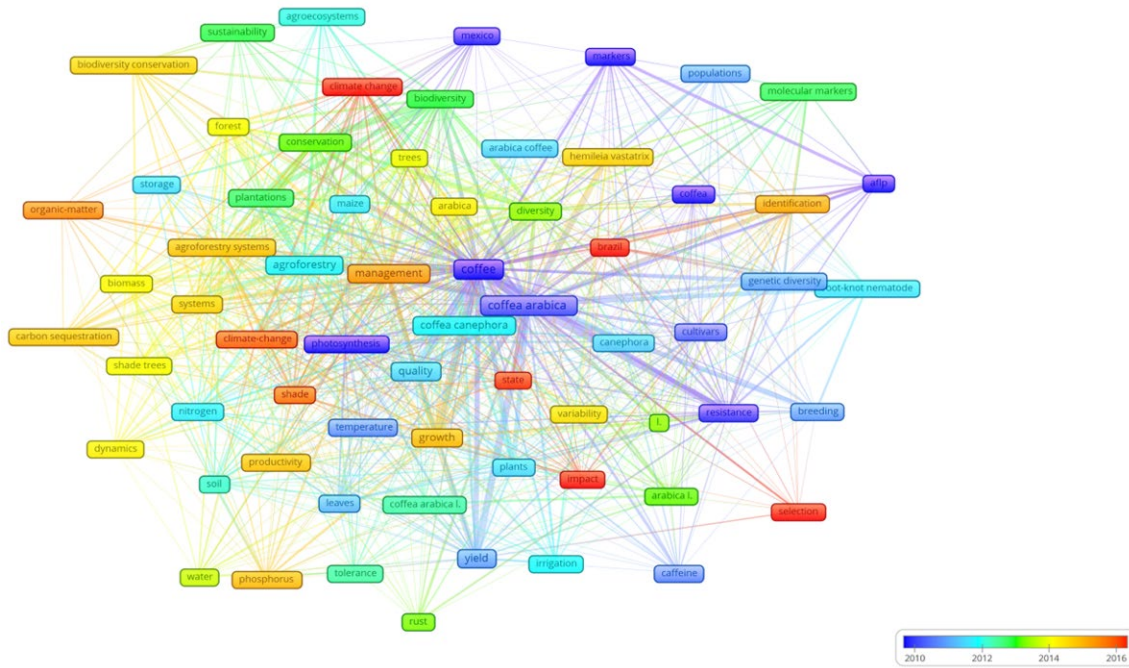

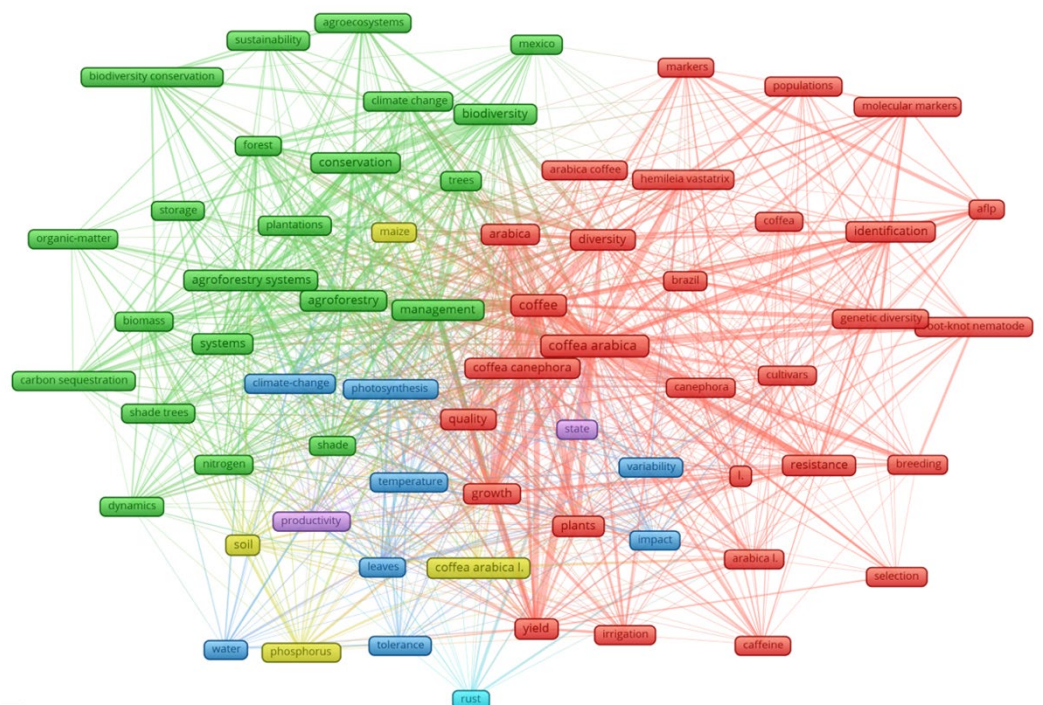**Figure 7.** Coffee agronomy research keywords co-occurrence network, temporary visualization.

Figure 8. Coffee agronomy research keywords co-occurrence network, thematic visualization.

4. Discussion

This article empirically contributes to establishing a general overview of the trends in the scientific production of coffee agronomy at the global level, which allows us to understand the structure of the epistemic community on this specific agronomic topic, managing to identify three main thematic areas of research of the coffee, a product of the various research agendas worldwide. Thematic coffee research areas, including the environmental sustainability of forestry, biological growth variables of coffee, and biotechnology of coffee species, display marked differences from a panoramic perspective of analysis. Although there are studies of literature reviews related to the areas of our findings, such as "Reductions in water, soil and nutrient losses and pesticide pollution in agroforestry practices: a review of evidence and processes" [109] and "Effects of shade trees on robusta coffee growth, yield and quality. A meta-analysis" [30]. These stand out for their use of multiple word combinations connected by Boolean operators but not an enveloping search vector [83], and the use of a selection method (e.g., PRISMA), which allowed them to systematize the selection of articles and to gain depth in their analysis, but their tendency to reduce the number of articles analyzed (only 83 and 30 articles, respectively) gives our study an advantage in terms of coverage by using bibliometrics as a meta-analytical method that is not reductive [110].

On the other hand, there is also literature review research such as "Remodeling agro-industrial and food wastes into value-added bioactives and biopolymers" [111] and "Challenges of organic agriculture to produce composts and vermicompost to produce medicinal plants—a socioeconomic demand" [109], which contribute to the topics related to the lines of study but possess less systematic rigorous methodology. In cases such as these, our research proposes a bibliometric methodology, defining a search vector, using homogeneous and structured databases, and incorporating a large sample size (1618 articles). Thus, in the extensive literature reviewed, no other mainstream articles have been identified that can provide a meta-analytical coverage as broad as ours, and no other sources have been identified that, to date, allow us to account for the tendency patterns that the global epistemic community of research on coffee agronomy has adopted over time. In the following conclusions, we will report on the diverse findings that are identified as results and their implications.

5. Conclusions

This article bibliometrically shows the existence of an exponentially growing trend of publications in this research topic, with an adjustment of over 80%, achieving a critical mass of documented scientific production in mainstream articles that show the interest on the part of the international scientific community for research in coffee agronomy. This growth rate of the published knowledge on coffee agronomy allows determining the average time with a period of current technical obsolescence, exceeding 12 years after the publication of a document, except for articles with citations above the historical average and determined as classics in this theme. Thus, in the period of contemporary production (2009 to date), three journals (JCR-WoS) are identified with a growing tendency to publish articles on this topic.

In turn, the article identifies a trend of three main journals that are concentrated in the first third of Bradford or core zone articles, with 30% of the total number of articles (482 of 1618) partly generated by the completion of registration of the journals Café Cacao The and Turrialba in the Journal Citation Report (JCR) of WoS. Thus, it is in the journals Ciencia e Agrotecnologia (published by the Federal University of Lavras), Agroforestry Systems (published by Springer, Kluwer Academic Publishers), and Cafe Cacao The (published by CIRAD—Cultures Perennes, only until 1994), where there is a broad and deep discussion on the topic under study. It should be identified that outside this Bradford core (Zones 1 and 2), there is an exponential diminishing of decreasing performance when trying to expand the search for references on coffee agronomy, as for this specific topic, it would be about peripheral scientific journals.

Geographically, the recent generation of knowledge presents a tendency to a concentration in Brazil as an emerging pole of knowledge production on coffee agronomy, which contributes with 655 articles out of a total of 1618 (40%). On the other hand, the Federal University of Lavras stands out both in the number of documents and citations. Regarding the level of authorship, according to Lotka's law, the conformation of five research groups stand out, where not only prolific authors (high production) but also prominent authors (high production and high citation) stand out, such as Paulo Tácito Gontijo Guimaraes and Philippe Lashermes. It is of future interest to be able to study them in isolation from the "other" authors with a smaller number of articles and establish in depth the origin of their unequal level of scientific production in comparison with the common authors on this topic. The scientific production that has been generated in languages other than English (23%) is also of interest to analyze in the future, especially the degree of international collaboration, citation, and use as input for other publications that transcend the base language.

As we have pointed out in our study, we also used Zipf's law to empirically determine the words with the highest frequency of occurrence (keywords and keyterms) in the set of articles studied. Thus, using fragmentation analysis through VOSviewer, thematic and time trend visualization outputs were analyzed. The thematic trends that have evolved in these six decades are identified to strengthen three major research areas: environmental sustainability of forestry, biological growth variables of coffee, and biotechnology of coffee species.

The limitations of this study are due to the wide coverage of articles reviewed (1618), which affects the degree of depth and specificity of the analyzes, and the results should be understood at the level of trends and meta-analytic behaviors. However, this opening of 5142 keywords also generates possibilities for greater segmentation at the level of systematic reviews, such as those mentioned in the discussion, in search of greater depth in specific topics related to coffee agronomy, and the panoramic character of the bibliometric meta-analysis escapes. Another limitation to be considered is related to the way in which both the authors, the journal, and WoS (Clarivate, London, UK) register data and metadata of the articles under study, especially due to the lack of uniformity in the terms used by the authors in the keywords, titles, and abstracts of their manuscripts. In view of this, the requirements of concentration and high occurrence imposed by bibliometric methods make it possible to generate error filters, assuming that errors in data and metadata should occur with low occurrence.

In terms of future research challenges, specific bibliometric and systematic review analyses in the three areas identified should be carried out as lines of future coffee agronomy research (silvicultural environmental sustainability, biological growth variables, and biotechnology of species). The strong relationship between coffee production, contribution in published articles, and local editions of magazines (JCR-WoS) in Brazil make it an interesting national case to study in greater depth and establish explanations of its evolution from coffee agronomic production to the production of knowledge on agronomic coffee.

Appendix A. Relevant Journals in Coffee Agronomy

This appendix details the 15 journals from major Bradford zones (2009–2020) shown in Figure 2 and Table 2. In Table A1, the journals are presented, detailing standardized abbreviated name, full name, International Standard Serial Number (ISSN), publisher, articles published in the Web of Science (WoS) database indexed between 1960–2020 and 2009–2020 (contemporary semiperiod), and the WoS categories to which the journal is attached.

Table A1. Details of journals from major Bradford zones (2009–2020).

Journals	Full Name	ISSN	Publisher	1960–2020	2009–2020	WoS Category
Cienc. Agrotec.	Ciencia e Agrotecnologia	1413-7054	Univ Fed Lavras	197	94	Agriculture, Multidisciplinary; Agronomy
Agrofor. Syst.	Agroforestry Systems	0167-4366	Springer	153	97	Agronomy; Forestry
Cafe Cacao The	Cafe Cacao The	0007-9510	CIRAD-Cultures Perennes	132	0 *	Agronomy
Turrialba	Turrialba	0041-4360	Inter-Amer Inst Cooperat Agric	127	0 **	Agronomy
Biosci. J.	Bioscience Journal	1516-3725	Univ Fed Uberlandia	61	57	Agriculture, Multidisciplinary; Agronomy; Biology
Cienc. Rural	Ciencia Rural	0103-8478	Univ Fed Santa Maria	57	48	Agronomy
Euphytica	Euphytica	0014-2336	Springer	52	21	Agronomy; Plant Sciences; Horticulture
Crop Prot.	Crop Protection	0261-2194	Elsevier	45	28	Agronomy
Crop. Breed. Appl. Biotechnol.	Crop Breeding and Applied Biotechnology	1984-7033	Brazilian Soc Plant Breeding	43	35	Agronomy; Biotechnology & Applied Microbiology
Exp. Agric.	Experimental Agriculture	0014-4797	Cambridge Univ Press	41	13	Agronomy
Ind. Crop. Prod.	Industrial Crops and Products	0926-6690	Elsevier	37	36	Agricultural Engineering; Agronomy
Acta Sci.-Agron.	Acta Scientiarum-Agronomy	1807-8621	Univ Estadual Maringa	36	35	Agronomy

Table A1. *Cont.*

Journals	Full Name	ISSN	Publisher	1960–2020	2009–2020	WoS Category
Eur. J. Plant Pathol.	European Journal of Plant Pathology	0929-1873	Springer	35	28	Agronomy; Plant Sciences; Horticulture
Plant Pathol.	Plant Pathology	0032-0862	Wiley	31	16	Agronomy; Plant Sciences
Rev. Agrogeoambiental ***	Revista Agrogeoambiental	1984-428X	Inst Fed Sul Minas Gerais	27	27	Agronomy

* In zero since 1995. ** In zero since 1991. *** Emerging Sources Citation Index, journal without impact factor calculation (IF). N/A: currently not available in the Journal Citation Report.

Appendix B. Prolific Authors by Cluster

This appendix details the five clusters of prolific coauthors network shown in Figure 6 (see Table A2).

Table A2. Cluster of prolific coauthors network.

Cluster	Authors
Cluster 1	Bartholo, Gabriel Ferreira Botelho, Cesar Elias Carvalho, Gladyston Rodrigues De Rezende, Juliana Costa Guimaraes Mendes, Antonio Nazareno Guimaraes, Rubens Jose Pasqual, Moacir Vallone, Haroldo Silva
Cluster 2	Baiao De Oliveira, Antonio Carlos Caixeta, Eveline Teixeira Cruz, Cosme Damiao Pereira, Antonio Alves Prieto Martinez, Herminia Emilia Sakiyama, Ney Sussumu Zambolim, Laercio
Cluster 3	Alves, Eduardo Alves, Jose Donizeti Curi, Nilton De Abreu, Mario Sobral Gontijo Guimaraes, Paulo Tacito Pereira, Igor Souza Pozza, Edson Ampelio
Cluster 4	Fazuoli, Luiz Carlos Guerreiro Filho, Oliveiro Ito, Dhalton Shiguer Sera, Gustavo Hiroshi Sera, Tumoru Silvarolla, Maria Bernadete
Cluster 5	Borem, Flavio Meira Da Silva, Fabio Moreira Fonseca Alvarenga Pereira, Rosemary Gualberto Malta, Marcelo Ribeiro Veiga Franco Da Rosa, Sttela Dellyzete

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