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SCIENTIFIC ARTICLES IN CHILEAN AGRICULTURAL SCIENCES 1989 - 2016: EVOLUTION, DISCIPLINES AND IMPACT IN TERMS OF LEADING IN THEIR FIELD

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ABSTRACT

We present the results from our research undertaken in the context of agricultural sciences in Chile, for a period stretching between 1989 until 2016, during which 5.873 scientific articles related to this scientific area were analyzed. For this research, bibliometric indicators of scientific activity were used to analyze the evolution of articles written for Chilean agrarian science, scientific collaboration, assessing which disciplines have received most attention and their overall level in terms of leadership. A sustained increase in scientific article output was observed to have taken place during the study period, combined with thematic concentration in the disciplines of veterinary sciences, fisheries and agronomy, and recent changes have also occurred in terms of how scientific collaboration is articulated, with more international participation, especially on the part of the United States.

Keywords: bibliometrics, Chile, agricultural science, scientific collaboration, internationalization, scientific production.

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INTRODUCTION

This article intends to analyze the output of scientific publications in Chilean agricultural sciences between 1989 and 2016, considering aspects of scientific collaboration, the disciplines most commonly worked on, and the degree to which articles have scientific impact. The relevance of this research lies in the fact that agrarian science represents one of the most relevant scientific areas of the Chilean scientific system, considering that after medicine, physics and astronomy, this constitutes the thematic area with the greatest output of scientific articles in the country, (Comisión Nacional de Investigación Científica y Tecnológica [CONICYT], 2017); likewise this constitutes a priority area for research and development (R&D) at the national level (13.6%) considering the Créditos Presupuestarios Públicos for R&D or (Government budget appropriations or outlays for R&D) GBAORD, (Ministerio de Economía, Fomento y Turismo MINECON, 2015).

In this section, we first present background information on the emergence and development of agricultural sciences, particularly the role that protagonists, institutions and procedures have played in Chile, in order to discern the prelude that has enabled current development of this scientific area in the country. Secondly, we present a section containing studies similar to the contents addressed in this article, where agrarian sciences are analyzed in different countries, using the tools of scientometrics and bibliometrics. Finally, we describe the current processes for internationalization of Chilean scientific activity, in relation to the decrease in indicators of scientific leadership, topics that we will address in the results of this research.

Regarding antecedents to the agrarian sciences, we should specify that the set of scientific areas that make up the agrarian or agricultural sciences corresponds to: i) agriculture, forestry and fishing, ii) animal and dairy sciences, iii) veterinary sciences and iv) other agricultural sciences, (Organización para la Cooperación y el Desarrollo Económicos [OECD], 2015). More precisely, agronomy initiated in the 19th century in response to market requirements, the needs of agricultural producers and the dissemination of scientific knowledge; a phenomenon that had radical impact on traditional production strategies, thanks to the incorporation of science, technology and innovation in the agricultural sector (Sarno and Caruso, 1996).

Fundamentally, the development of agrarian sciences in Latin America has been assisted by the public sector through universities and technological institutes, due to limited private participation (Pomareda and Hartwich, 2006); until 1973, 2% of public budget was directed towards these goals (Valdés and Foster, 2005). In Chile, as in other Latin American countries, there were instances of scientific and technological innovation related to ecclesiastical institutions, the Spanish Crown and the Creole elite. In the case of agrarian sciences, during the first half of the 19th century, there were precursors such as Vicente Bustillos and Ángel Vásquez, who worked in the context of meat preservation applying chemical methods (Gutiérrez and Gutiérrez, 2008). Luis Sada, an Italian agricultural engineer, represents another of the forerunners of agricultural sciences in Chile. In 1849 he arrived in the country, hired by the government of this country to direct the Escuela Práctica Agrícola (School of Practical Agriculture) and administer the Quinta Normal de Agricultura in Santiago (Sada de Carlo, 1860). In 1865, by order of the State of Chile, Claudio Gay published the first volume of Historia Física y Política de Chile (Physical and Political History of Chile) dedicated to agriculture (Gay, 1862).

Regardless of the important role played by these early individuals in agrarian sciences, the period when these and scientific activity in general in the country were institutionalized, took place between 1955 and 1970 (Salinas, 2012) with the most important stage occurring in 1967, with the establishment of CONICYT dependent on the Ministry of Education, whose mission was to advise the presidency on matters of scientific development. During the sixties, the country witnessed the establishment of various public institutions with the aim of contributing to the generation and dissemination of knowledge that would allow the implementation of better public policies, encompassed in a broader process for State modernization, at the time. Correspondingly, in the case of agrarian sciences, in 1962 the Instituto de Desarrollo Agropecuario (INDAP) (Agricultural Development Institute) was created, and in 1964 both the Instituto de Investigaciones Agropecuarias (INIA) (Agricultural Research Institute) and the Instituto de Fomento Pesquero (IFOP) (Fisheries Development Institute).

Some of the programs for promoting science, by CONICYT, were initiated in 1982, with the Fondo Nacional de Desarrollo Científico y Tecnológico (FONDECYT) (National Fund for Scientific and Technological Development) oriented towards scientific research and in 1992, with the Fondo de Fomento al Desarrollo Científico y Tecnológico (FONDEF) (Fund for the Promotion of Scientific and Technological Development),

oriented to public-private collaboration and applied research. As CONICYT does not have regional departments, in 2000 it created a Regional Program with the aim of promoting and strengthening scientific activity in provincial areas of Chile, which made it possible to inaugurate focused Regional Research Centers, some of them dedicated to the agri-food industry. Notably, at the present time, after 52 years of CONICYT operating, in 2020 the Agencia Nacional de Investigación (ANID) (National Research Agency) was inaugurated; a service in charge of administering and executing the programs and systems destined to promote, encourage and develop research in all areas of the knowledge, technological development and innovation, based on science and technology, in conformity with the policies defined by the Ministry of Science, Technology, Knowledge and Innovation in Chile.

To promote innovation in the agricultural field, in 1997 the Ministry of Agriculture inaugurated the Fundación para la Innovación Agraria Foundation for Agricultural Innovation together with the Fondo para la Innovación Agraria (FIA) (Fund for Agricultural Innovation). Finally, at a strategic level, the creation in 2005 of the Consejo Nacional de Innovación para la Competitividad (National Innovation Council for Competitiveness) is relevant, as its objective was to advise the Presidency of the Republic on matters of innovation, an area in which scientific research and improvement in terms of business competitiveness are combined. The contribution of agricultural research and expansion in Chile has declined in tenacity in the long term and the institutional infrastructure that promotes scientific research, development and training has faced difficulties as a result of being incorporated into the private sector (Valdés and Foster, 2005 and Arias and Zuluaga, 2014).

Secondly, regarding content analysis and charting of knowledge in agrarian sciences, there is a history of scientometric and particularly bibliometric studies, dating from 1989 that includes a comparison of South Africa with countries in North America, Latin America, Asia, Oceania and Africa. This discusses their contribution to international agricultural research, revealing poor participation on the part of South Africa, but showing certain impact at the national level in the sub-disciplines of Dairy and Animal Products and Plant Sciences (Pouris, 1989).

Regarding the transmission of agricultural knowledge, research indicated that between 1973 and 1982, citation of Latin American articles was low, whereas citations to national scientific articles were predominant; while also demonstrating that most of the citations to foreign articles corresponded to authors from institutions in Europe and the United States (Thorpe and Pardey, 1990).

Particularly in Argentine agrarian sciences, and over the period from 1997 to 2009, a study confirmed low international collaboration in scientific research, and what existed was mostly directed towards the United States (Rojas-Sola and San Antonio-Gómez, 2010). The agricultural scientific output from India between 1993 and 2002 was also analyzed, where the sub disciplines of veterinary sciences and in particular topics concerning dairy, were the most commonly addressed by the institutions in that country (Garg, Kumar and Lal, 2006).

More recently, a study based on delineation of knowledge, identified the subjects of grazing, forestry, beef and dairy farming, field crops, pedology and plant selection as emerging areas of knowledge in Russian agricultural sciences; this procedure focused on doctoral theses of researchers between 2008 and 2015 (Devyatkin, Nechaeva, Suvorov, and Tikhomirov, 2018).

Thirdly, regarding the processes of internationalization and scientific leadership, in Chile, over the last twenty years, scientific activity has made important advances in terms of levels of financing, output of scientific articles (Di Meglio, 2018 and Santélices, 2015) and especially concerning internationalization processes that lead to greater scientific collaboration and published articles that have impact (Matus, 2015). However, it is worth questioning current levels of leadership related to the process of greater scientific production and how the results of international collaboration are positioned in the scientific context. In Chile and other Latin American countries, achieving higher levels of scientific impact for published articles has resulted in a decrease in leadership, understood as diminishing ability to publish leading articles in quartile 1 journals. In other words, an increasing number of articles are published in high-impact journals but in the form of co-authorships (CONICYT, 2015). In particular, considering the 2015 report: the principal scientometric indicators of Chilean scientific activity, period 2003-2013, showed that the increase in the scientific impact experienced by Chilean science as a whole, implied a loss of leadership, a phenomenon captured by the indicator "leading scientific output" (CONICYT, 2015). The same report states that the main reasons to explain this situation correspond to the increase in large international scientific projects in consortium, where Chilean institutions participate and a greater number of national journals with a presence in international indices –a situation similar to that of other countries with less scientific development– (2015).

The loss of scientific leadership has been termed "subordinate integration" by Pablo Kreimer, a concept that refers to the lower incidence in the programmatic decisions that Latin American research groups have in terms of their participation in international scientific networks, in the sense that networks are likely to be structured using funds from the European Union or the United States (Kreimer, 1994), but where funds from peripheral countries also participate as part of this international collaboration (Kreimer, 2011), all in a global context of "expansion" of international scientific collaborations since the 1990s (Persson, Glänzel, and Danell, 2004). According to the author, a type of international division of labor could also be implemented for the generation of scientific knowledge. This subordinate integration would result in "topical ultra-specialization by Latin American communities, as opposed to the principal elaboration of topics, instead examining more specific and functional aspects of science on a larger scale, thus inhibiting possibilities for articulating the production and the use of knowledge" (Kreimer, 2002, p. 300).

METHODOLOGY

Selection of databases: two criteria were considered in order to define the bibliometric sample: the first regarding volume of information, which required selecting those departments characterized by having a large number of scientific articles. The second

referred to the type of publication circuit, which would allow simultaneously obtaining scientific articles pertaining to international science, as well as those circulating in more local and regional contexts. Therefore, we decided to use the Web of Science (WOS) listing to obtain the bibliometric sample, including all its available databases. Therefore, articles that were indexed differently were not taken into account.

Definition of bibliometric sample: the minimum unit of study was the scientific article, as these constitute documents that condense novel scientific knowledge in a standardized way. The timescale of the study had to fall between 1989 and 2016. Likewise, the articles had to form part of Chilean scientific production, that is, at least one of their authors had to be affiliated to a Chilean institution. To check they belonged to the agrarian sciences, the following classifications in WOS categories were used in the searches: a) agronomy, b) agriculture, multidisciplinary, c) forestry, d) soil science, e) horticulture, f) fisheries, g) agriculture, dairy and animal science, h) agricultural engineering, i) veterinary sciences, j) agricultural economics and policy.

Definition of search strategy: the search was undertaken in two stages: the first constituted a consultation with experts in the area, in order to define the "WOS categories" that form part of the agrarian sciences. We should emphasize that inevitably, beyond the limits of this sample, there are scientific articles published in other scientific categories or journals not recognized by these experts. For this first list, a preliminary search was carried out and a second list of related WOS categories was selected, which was then revised by the experts and compared with the OECD classification: i) Agriculture, forestry and fishing, ii) Animal sciences and dairy, iii) Veterinary sciences and iv) Other agricultural sciences, thus obtaining the final list for defining the bibliometric sample.

Information storage: once the search was finalized, we decided to store the bibliographic information in a database, organized according to the type of information referred to: a) contents, b) agents, c) documents and d) their classifications. From the WOS platform, 5,873 records were obtained.

Data refinement: from the final database, procedures for authority control were carried out. In the agents' information, the names of authors were standardized as follows: "First Surname, Initial letter of first name, period" (example: Polanco, X.). When the last name and first name of a new author coincided, the initial of his middle name was added (example: Polanco, X.G.). This procedure required great thoroughness because the information downloaded from WOS is not always complete, making it necessary to search the names individually, in order to reduce the effect of duplication on the data, resulting in 12,048 original authors.

Definition of bibliometric indicators: to carry out this research, bibliometric indicators were used, which are presented in this section to explain the context and focus of this research. In the first place, it should be noted that there are at least three types of widely used bibliometric indicators: i) activity indicators, which seek to quantify results from scientific activity, ii) first-generation relational indicators, focused on the networks that sustain the production cycle of these results and iii) the second generation relational indicators, which include the scientific content of documents, to account for the expressions and logical

relationships between them (Escalante, 2009 and Callon, Courtial, and Penan, 1995). In the present study, we mainly used bibliometric indicators of activity, which were later grouped into 5 types:

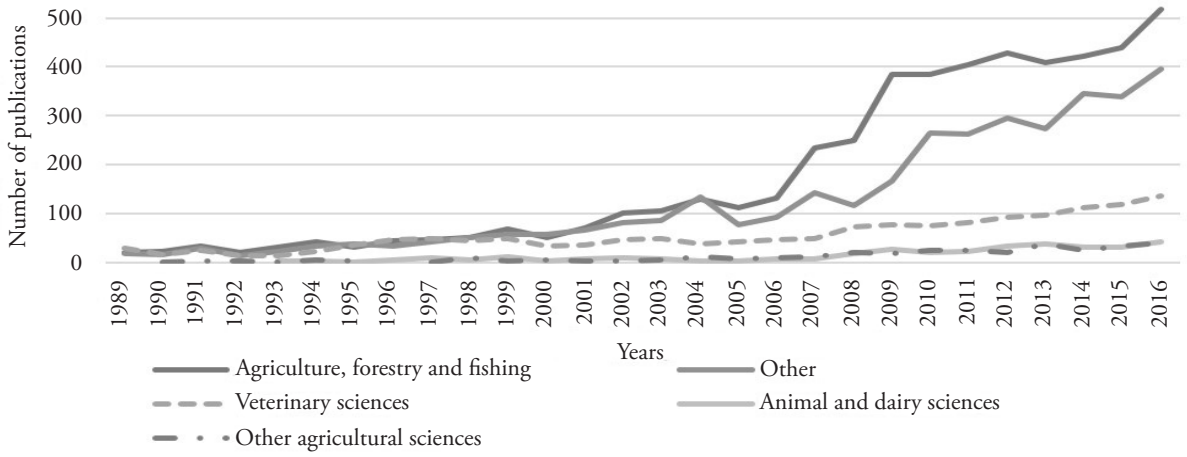
1. Scientific output indicators: these account for the results obtained from scientific activity and can be divided according to the different actors present.
2. Indicators of scientific collaboration: these account for scientific activity or results from this, carried out by means of strategies for collaboration.
3. Indicators of the scientific classification system: these account for the distribution of publications according to the different types of thematic and disciplinary classifications in science.
4. Indicators of the scientific publication system: these account for the distribution of publications based on the different channels and platforms by which articles are diffused to the public.
5. Indicators of scientific leadership: these account for scientific output with respect to its position, understood as the type of authorship pertaining to scientific articles.

RESULTS

Scientific production

In Chilean agrarian sciences, the number of scientific articles published has steadily increased. In 1989 there were 48, whereas in 2016 there were 584 articles. Considering only levels of scientific production, three major periods of growth were identified: the first, from 1989 to 1999, the second, from 2000 to 2006, and the third period, with the greatest increase, from 2007 to 2016. During the years 2000-2001, scientific production in terms of agrarian sciences increased exponentially, and it was apparent that the sub-category; agriculture, forestry and fishing was most associated with this growth trend, a phenomenon that is made clear, as it represented more than 70% of publications. Although all tended to increase, the other sub-areas did not exceed 103 additional publications during the growth period from 2007 until 2016, contrasting with 466 publications in the main sub-category. Considering veterinary sciences, although these did increase, they began to do so late (2008) compared to agriculture, forestry and fishing. The same occurred with animal and dairy sciences and other agricultural sciences, whose number began to increase in the same year. The Figure 1 also indicates the evolution of the "rest" of the sub-categories. Their elevated growth and similar pattern of evolution to that of agriculture, forestry and fishing, suggest that they were mainly influenced by this sub-category, demonstrating the central position this occupied in the scientific activity of agrarian sciences in general.

Of all the articles published, 88% were published in scientific journals, indexed in the WOS platform and only 12% in doubly indexed platforms; Wos-SciELO. Observing the distribution of articles throughout the study period, it was clear that articles indexed in doubly indexed platforms (SciELO and WOS), maintained a constant number of published articles. Notably, the articles indexed in the WOS platform achieved sustained growth, reflecting that they have constituted and promoted the increase in Chilean



Source: own elaboration.

Figure 1. Chilean agrarian sciences. Evolution of scientific output in terms of OECD sub-categories.

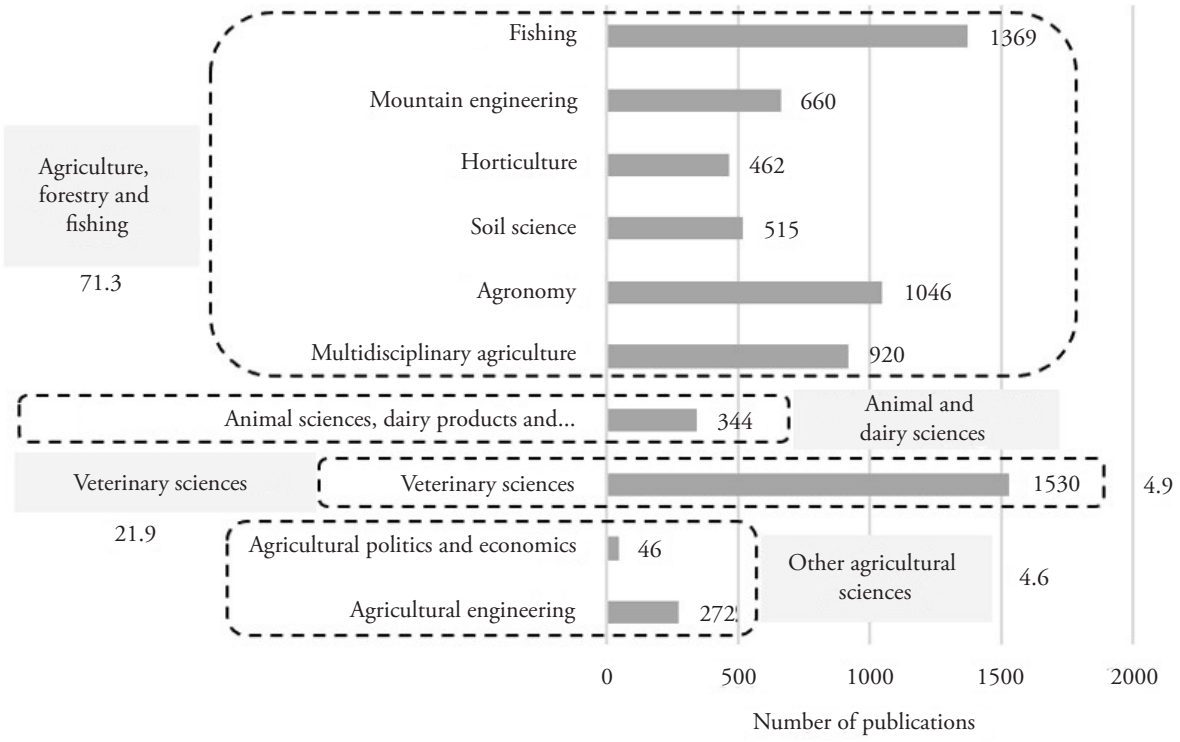
agricultural sciences as a whole. From the year 2000 –during which a record number of SciELO articles are registered– until 2006, the articles with WOS and SciELO indexation showed very similar output.

This growth results partly from the greater number of researchers participating in the Chilean research system, but it also reflects the aspects indicated in the theoretical framework, where a greater deployment of institutions and procedures related to the promotion of sciences and agricultural sciences in particular is apparent, which form the basis of this boom and, in addition to expanding it in quantitative terms, offering greater complexity and thematic specialization, as the following results make evident.

Scientific classification

Figure 2 reflects the distribution of scientific articles according to the WOS categories in which they were classified. Only those categories that we identified in the methodological design, as pertaining to the agrarian sciences and that corresponded to the core categories of this field of study were selected. Overall, veterinary sciences was the discipline used to classify the greatest number of articles (1,530), followed by fisheries (1,369) and agronomy (1,046). Grouping these according to the OECD thematic classification (sub-areas), it is evident that agriculture, forestry and fishing were present in 71.3% of the publications, becoming the sub-area with greatest development and complexity. Fewer articles were produced in veterinary sciences, with 21.9% in animal sciences, 4.9% in dairy and in other agricultural science sub-areas 4.6% of publications.

As made evident in this classification, if only volume of scientific output is considered, Chilean agricultural sciences manifest certain areas of knowledge with greater specialization. This is reflected in veterinary sciences, fisheries and agronomy, an aspect that, although it cannot be directly related, may be associated with the Chilean productive matrix, which principally focuses on forestry and agricultural products.

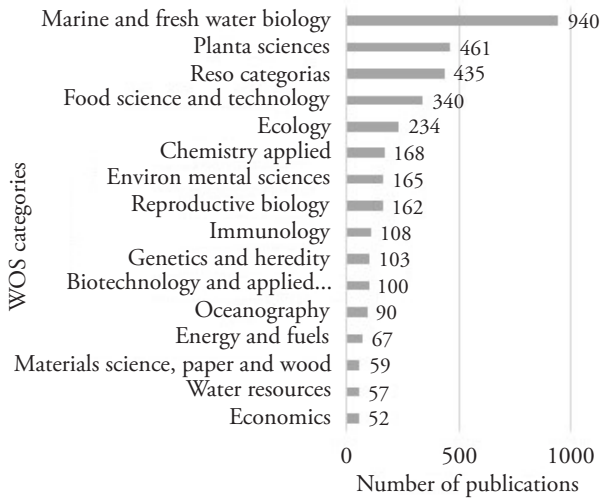


Source: own elaboration.
Figure 2. Chilean agrarian sciences. Distribution of publications from the sample defined by WOS categories, according to OECD classification.

Agricultural sciences are made up of the ten disciplines outlined above. However, as often occurs with scientific activity, other disciplines that do not necessarily belong to the central nucleus of agrarian sciences are activated by it, in the sense that each article can relate to several categories simultaneously from other scientific areas, reflecting certain interdisciplinary tendency in Chilean agricultural sciences. Correspondingly, in the following analysis, we present the non-sample WOS categories that were most often linked to agrarian sciences (at least 50 shared articles).

Results indicated that the discipline with the greatest presence was marine and freshwater biology, representing 16% of the total. This was followed by plant science, food science and technology, and ecology. The other categories displayed in the Figure 3 showed a presence of less than 200 articles but all exceeded 50; the category of economy was the last one displayed. The rest of the 39 categories registered less than 50 articles and consisted of a total of 435 articles.

Evidently, and concerning the results that revealed fisheries as the discipline of agrarian sciences with greatest prominence (Figure 2), it is possible to relate marine and freshwater biology with the Chilean agrarian sciences in this interdisciplinary process. However, as can be seen in the Figure 3, when compared to this discipline, the rest of the disciplines have a lower position in terms of scientific articles. This may indicate greater specialization



*From a total of 55 WOS categories, without considering those from the sample.
Source: own elaboration.
Figure 3. Chilean agrarian sciences. Distribution of publications by WOS categories most linked to the sample*.

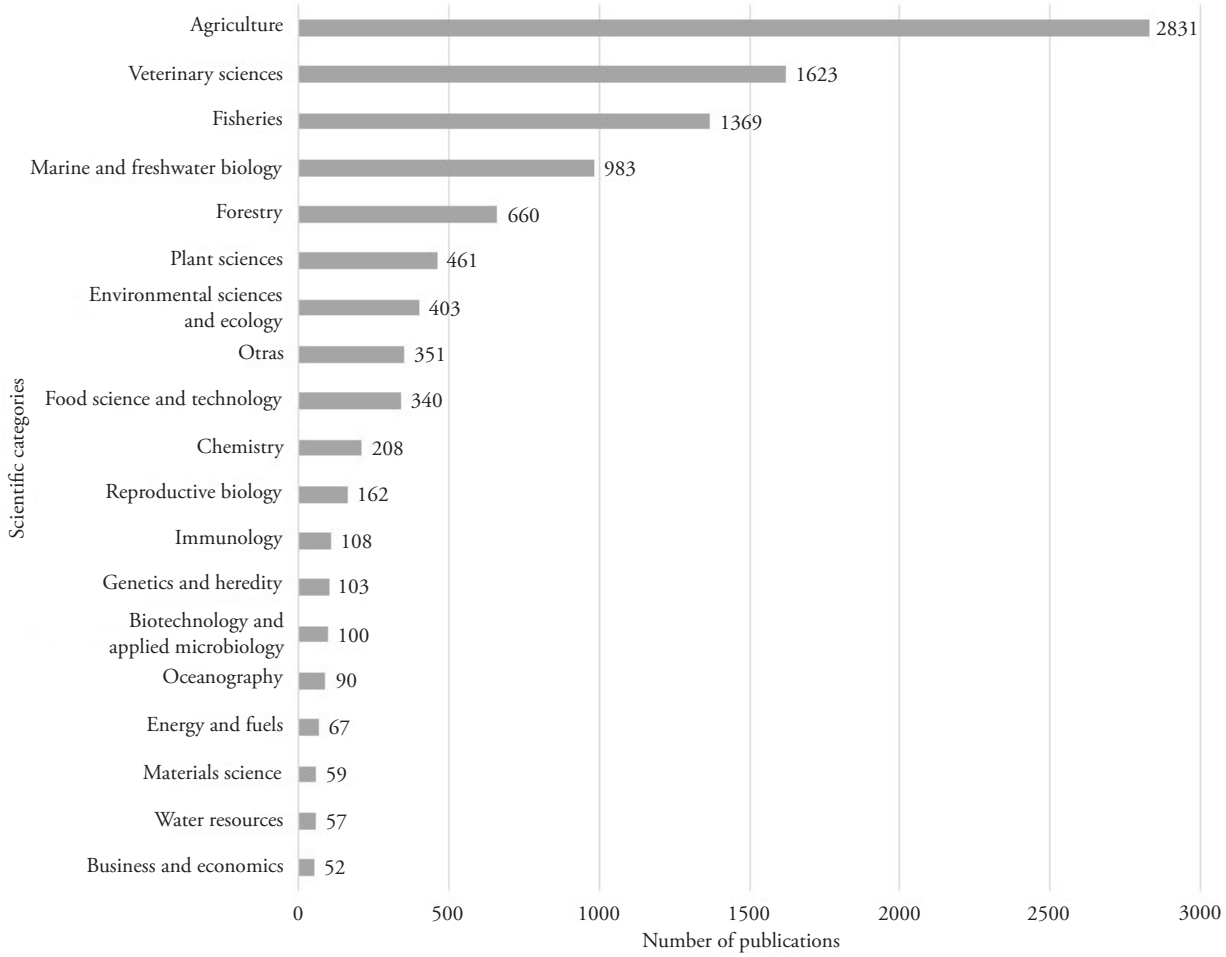
in terms of the scientific field, or otherwise, some limiting factor, as no further disciplines among the agrarian sciences can be included as protagonists.

The WOS platform made it possible to classify the articles according to scientific categories, which in several cases are similar to the WOS categories, but in others they respond to alternative groupings of the documents. In this case, it was observed that the scientific category of agriculture had the greatest number of publications, whereas veterinary science only 1623 articles. Contrary to what happened with the WOS categories, in this case, the category agriculture grouped several equivalent categories in WOS, roughly coinciding with the sub-area of agriculture, forestry and fishing, with the exception that for this classification, fisheries is autonomous (Figure 4).

This analysis allows us to confirm the influence that the areas of fisheries and agronomy have had on Chilean agricultural sciences from 1989 to 2016, previously shown to be relevant according to other types of classifications. Although some ideas have been put forward to explain this phenomenon, such as the greater number of researchers and the role played by fishery and forestry products in the Chilean economy, the scope of these data does not make it possible to corroborate these conjectures, but opens paths for future research in this matter.

Internationalization and scientific leadership

Scientific collaboration is registered, when at least two authors from different institutions publish a scientific article together and international collaboration with Chilean agricultural sciences occurs when there is at least one author affiliated to a Chilean institution, who publishes a scientific article together with at least one author affiliated to a foreign institution. Regarding the characteristics of the internationalization of Chilean

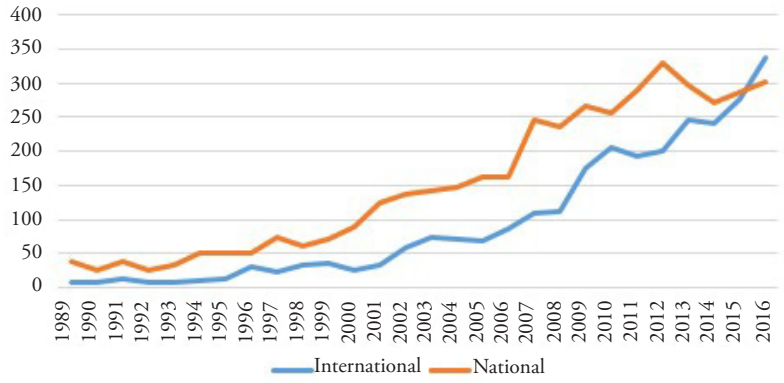


Source: own elaboration.
Figure 4. Chilean agrarian sciences. Distribution of publications by scientific categories.

agricultural sciences during the study period, Figure 5 shows an upward curve, from at least the year 2000, for both national and international collaboration. However, national collaboration has tended to be greater during much of the period, a situation that has been changing since 2013 from which time, international collaboration has nearly matched the national, even surpassing it in recent years.

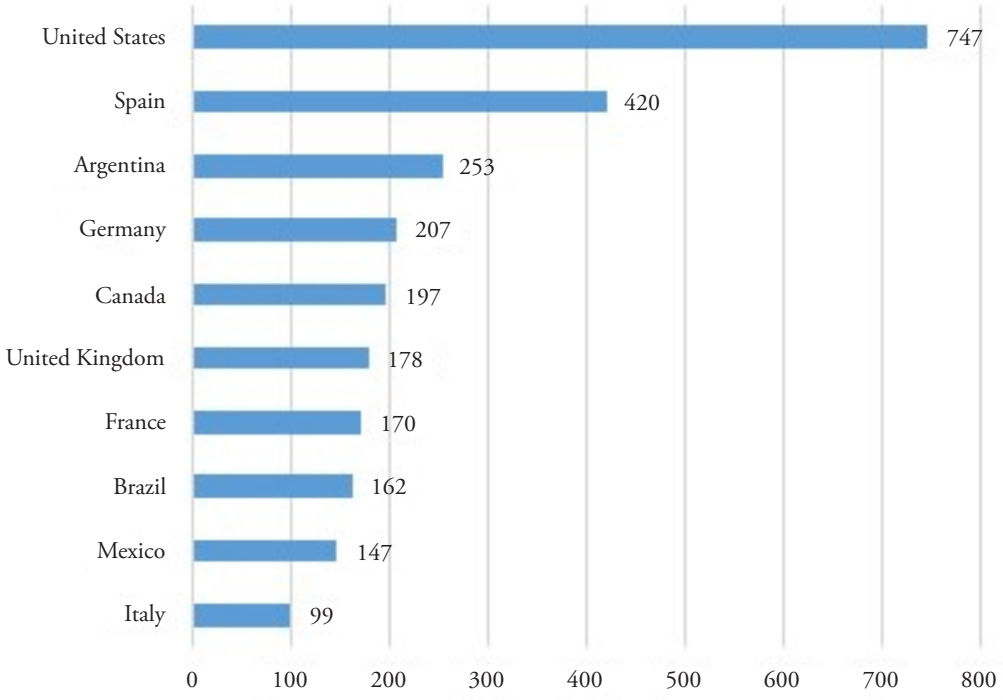
This surpassing of international collaboration over national collaboration only occurs after 2015 and could result from the inauguration of new guidelines concerning the type of scientific collaboration on the part of Chilean agricultural sciences, as it corresponds to the initiation of a new collaborative strategy for the development of this scientific field. This shows no decrease in the proportion of scientific collaboration in the national context, but instead, an accelerated increase in international participation in this scientific area.

Figure 6 shows the 10 principal countries with which Chilean institutions have established greatest institutional collaboration through co-authorships. It is



Source: own elaboration.
Figure 5. Evolution of national and international collaboration in Chilean agrarian sciences.

apparent that authors from Chilean institutions have collaborated with authors pertaining to institutions located in the United States to produce 747 publications, almost double that of the number of authors pertaining to institutions in Spain (420), followed by Argentina, Germany, Canada, United Kingdom, France, Brazil, Mexico and Italy.



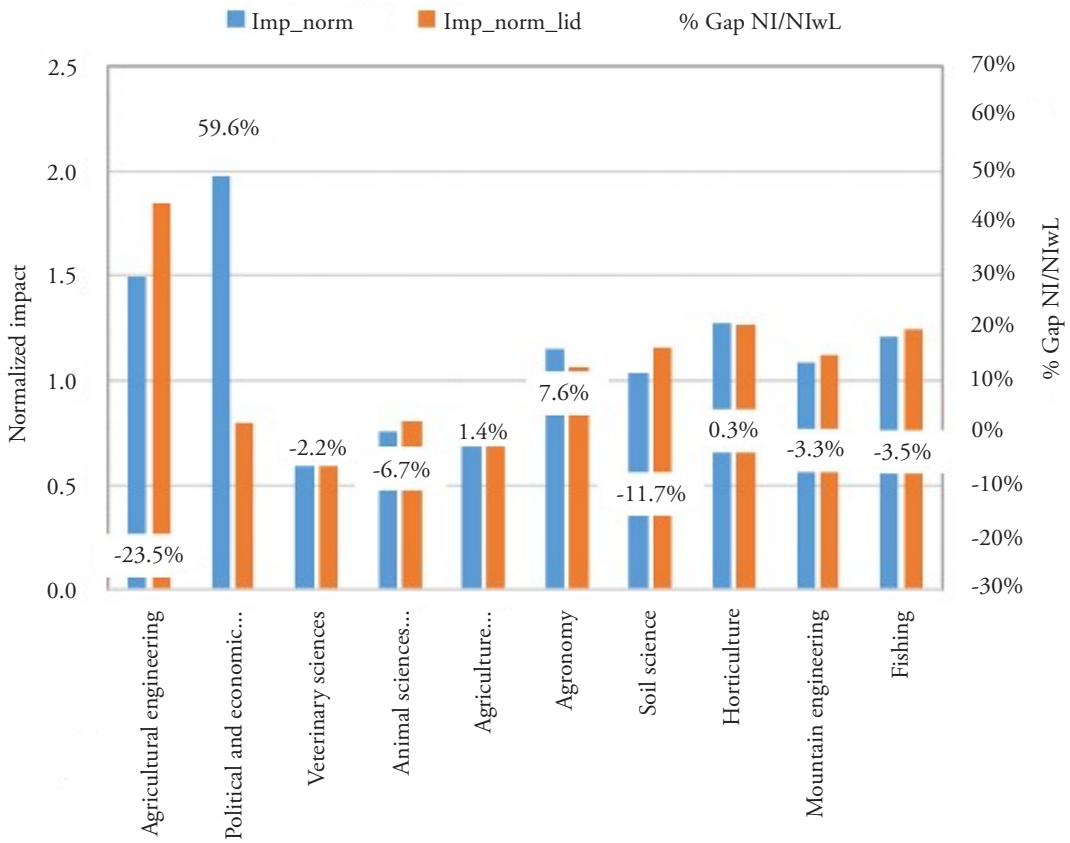
Source: own elaboration.
Figure 6. Main 10 countries distributed according to the number of documents collaborating internationally.

In the previous analysis (Figure 5), we indicated that since 2015, Chilean agricultural sciences have modified their collaboration patterns, so that international participation begins to be stronger even than the national. With the present analysis reflected in Figure 6, evidently change predominantly occurs due to the influence of United States institutions that have generated higher levels of exchange with Chilean institutions for the production of scientific articles in agricultural sciences.

As noted above, international scientific collaboration in agricultural sciences has increased in recent years, surpassing that of national collaboration since 2015. Likewise, the country which has generated greatest collaboration has been the United States. However, the type of relationship that exists in this collaboration should be examined, in terms of capacity for scientific leadership. Regarding our comments in the introductory section, in Chile, it is apparent that obtaining greater levels of scientific impact on the part of published articles, has resulted in a decrease in scientific autonomy, reflected in a deceased capacity to publish leading articles. Even if these results are global for Chilean science, it is worth questioning the particular situation of agricultural sciences. To answer this, the Figure 7 shows the difference between normalized impact (NI) and normalized leading impact (NIwL) for the disciplines of Chilean agricultural sciences, following recommendations from the report "Main scientometric indicators of Chilean scientific activity 2012" (CONICYT, 2014). Normalized impact (NI) is an index that compares the average number of citations received by published documents pertaining to a discipline, with the number of citations received by total scientific production in that field (Chilean agrarian sciences), during the same period. This is an indicator of overall tendency, which characterizes a community as a whole. The normalized leading impact (NIwL) is the same index as above, which is calculated considering only total leading output. Unlike the previous indicator, the NIwL is not affected by leadership from outside the discipline.

These percentages reflect the difference in percentage between the NI and the NIwL, known as the NIT/NIL Gap, which is expressed as a percentage on the right y-axis. The disciplines that show a lower NI/NIwL percentage ratio denote high scientific autonomy, especially those whose percentage is negative, as the leading normalized impact would be more important. Scientific autonomy is associated, among other traits, with the possibility that a discipline has of defining which topics are worthy of research, as well as the possible appropriation of results from research projects. As disciplines become more dependent, they lose cognitive control in terms of a research agenda, understood as the degree of freedom to define the agenda of their research topics. Contrastingly, disciplines that show a higher ratio of NI/NIwL percentage Gap denote low scientific autonomy, limiting the agenda of their research topics to logistics of the general context rather than related to their discipline in particular.

Finally, it is apparent that the disciplines of agricultural engineering and soil sciences are those that presented greatest autonomy within the Chilean agricultural sciences, during the study period, followed by animal sciences and dairy, fishery, forestry or forestry engineering, veterinary sciences, horticulture, interdisciplinary agriculture, agronomy, but above all agricultural politics and economics, are the disciplines whose NI/NIwL



Source: own elaboration.
Figure 7. Total normalized impact versus leading impact (1989 – 2016).

percentage Gaps are greater than the previous ones, representing disciplines with less autonomy in their fields.

CONCLUSIONS

In terms of conclusions, we indicate some relevant aspects that relate to the type of behavior manifested by Chilean agrarian sciences between 1989 and 2016. Apparently, the publication of scientific articles on agrarian sciences increased steadily, with the greatest boom occurring between 2007 and 2016. Chilean agrarian sciences concentrated its research to the area of agriculture, forestry and fishing, a context that includes six of the ten disciplines that make up agrarian sciences, among which, more specific analysis, highlighted the areas of veterinary sciences, fishery and agronomy. The least studied areas in fact corresponded to factors that were complementary to agricultural sciences, denominated by the OECD classification, as other agricultural sciences including Agricultural Engineering and Agricultural Politics and Economics. Agricultural sciences are articulated according to specific problems that nations have, whether these are due to

productive, economic or environmental aspects, among others, so the concentration in only three large areas also reflects the setbacks and challenges that Chile has faced, regarding diversification of its productive matrix. In this sense, Chilean agricultural sciences are very relevant in terms of the role they play in Chilean scientific work, where there are multiple universities, research centers and institutions strictly focused on the development of this scientific field. This was partly explained in the theoretical section, where we identified the appearance of various agents, which as the result of the promotion of basic sciences, research, development and innovation, have generated a propitious platform for the deployment of agricultural sciences. However, during the study period, it was possible to identify the tendency and differentiated role of disciplines such as agronomy, fisheries, veterinary sciences, which have distanced themselves from the other disciplines involved in this field, and reflect the importance of this scientific field in Chile.

Correspondingly, marine and freshwater biology - a discipline that pertains to the natural sciences - was the one that most commonly complemented the Chilean agrarian sciences, a situation that is comprehensible because of the high output of scientific articles related to the Chilean fishery during the study period, which reflected a high level of interdisciplinary activity. Since 2007, agrarian science articles indexed in WOS journals increased more than SciELO articles and doubly indexed (WOS and SciELO). This situation can be explained by the interest on the part of the Chilean scientific community, who participate in agricultural sciences, in focusing their efforts on international publication circuits and by the greater number of scientific journals available with WOS indexing. This phenomenon is not strictly limited to agricultural sciences, but may include other scientific contexts in the country, due to the structure of incentives in scientific careers.

Science in Latin America is going through changes in terms of collaboration patterns, so that certain research groups are internationalizing their networks which, in the case of Chilean agricultural sciences, are mostly concentrated in the United States. However, this interaction has not been exempt from complications regarding the way in which the communities are structured and the type of link they have with the countries of Europe and the United States, where the Latin American groups are less likely to participate as protagonists in research agendas involving international collaboration. Although the scope of this article does not intend to resolve the complexity of this phenomenon, it does enable an initial appreciation, regarding the different internal disciplinary behavior on the part of Chilean agricultural sciences, noting different levels of autonomy and scientific leadership concerning their international inclusion. This is complemented by the scarce participation in disciplines such as Agricultural Politics and Economics, where in Chile a low output of scientific articles was identified, also showing low levels of leadership. This type of discipline, which makes it possible to structure the mostly epistemological components of a scientific area, has been far from the focus of research in agrarian sciences in Chile. This also explains the greater concentration in more limited study contexts, promoting the initiation of new challenges in the broader field of Chilean agrarian sciences, regarding the type of participation that is undertaken concerning scientific activity, as well as state backing for the promotion of science, technology, knowledge and innovation in this context.

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