A bibliometric analysis of the scientific production related to “zero hunger” as a sustainable development goal: trends of the pacific alliance towards 2030

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Abstract

Background: In 2015, The United Nations (UN) established 17 Sustainable Development Goals (SDGs) by 2030. In Latin America, the Pacific Alliance is integrated by Chile, Colombia, Peru, and Mexico, which the scientific activity is focused on the scientific production from research and academic institutions. In this study, the main goal was to analyze the scientific production (2015–2019) in the Pacific Alliance related to “zero hunger” as SDG. The bibliometric analysis of the scientific literature was carried out using the Scopus database with search terms related to zero hunger and validated by Elsevier. We analyzed the annual production of original articles, productive journals, leading institutions, funding agencies, authors, and the most influential original.

Results: Our results showed that the Pacific Alliance produced 2215 (81.0%) original articles, which is the fraction of non-excluded outputs with an annual growth rate of 12.62%, Mexico was the leading country, Nutrición Hospitalaria was the most active journal, and The Universidad Autónoma de Mexico was the leading institution and CONACYT as the leading funding institution.

Conclusion: As conclusion, the scientific production of the Pacific Alliance is showing positive substantial changes, which reflects the main research themes related to zero hunger, such as food security, sustainable agriculture, and malnutrition to achieve this SDG by 2030.

Keywords: VOSviewer, Bibliometric indicators, Science mapping analysis, Scientometric, Zero hunger, Sustainable development, Agriculture

Background

The Sustainable Development Goals (SDGs) were adopted by all United Nations (UN) Member States in November 2015 as a global agenda to end poverty, protect the planet, and ensure that all people enjoy peace and welfare by 2030 [1]. As of January 2016, SDGs replaced the Millennium Development Goals (MDGs), which nowadays are conformed by 17 SDGs and 169 targets, focusing on environmental, economic, and social sustainability [2]. However, SDGs are not only focused on developing countries, because the agenda towards 2030 covers all countries and sectors of the society [2].

SDG 2 called “zero hunger” has specific targets mainly environmental problems such as biodiversity, agricultural productivity, and sustainable production systems together with the serious consequences of climate
change, the elimination of hunger and malnutrition, as well as the control of micronutrient deficiencies in different age groups and the socioeconomic factors involved that encompass farmers and commercial markets leading to a very in-depth investigation of them [4].

Zero hunger as SDG seems to be promised with ending all forms of undernourishment by 2030 and ensure that all people, especially children, have access to sufficient and nutritious food throughout next few years [3]. Several tasks have been involved by the UN to achieve this goal by 2030 such as promoting sustainable agricultural practices to obtain better crops, these activities must be practiced such as cover crops, crop rotation, permaculture, soil enrichment, natural pest predators, bio-intensive integrated pest management, polyculture farming, and others [4]. It is known that hunger and undernourishment remain as the main barrier for the development in many countries as a direct consequence of environmental degradation, drought, loss of biodiversity, and a growth of urban cities [5].

According to the UN, in the world, more than 90 million children under the age of 5 are dangerously underweight, being the malnutrition and food insecurity as the leading causes in all regions of Africa, as well as in South America [3, 6]. In 2018, famine affected 42.5 million people in Latin America and the Caribbean, according to the new joint UN report [9]. In fact, in South America live the majority (68%) of undernourished people from Latin America and this observed increase in recent years is due to the economic slowdown experienced by Latin America countries. On the other hand, the Food and Agriculture Organization (FAO) revealed that undernourishment in 2018 had a prevalence of 6.1% in Central America and 5.5% in South America, respectively [10]. However, numerous efforts of each country try to stop the undernourishment and according to the Global Hunger Index (GHI) Chile is the country that has had a better index from 2000 to 2020 followed by Peru, Colombia, and Mexico, respectively [3].

On the other hand, the Pacific Alliance (PA) is a regional integration initiative, which was announced in Lima (Peru) on April 28, 2011, through the Lima Declaration made up of four member countries: Chile, Colombia, Mexico, and Peru, four countries in the incorporation process, four associated countries, and more than 40 observer countries on four continents [7]. PA presents four main axes as vision being: more integrated, more global, more connected, and more citizen. The last vision englobes to achieve the SDGs and ensure that the benefits of the PA reach all citizens, contributing to overcoming inequality and poverty, and have a sustainable agenda with joint projects for the adaptation and mitigation to the effects of climate change and energy clean, among others [7].

Bibliometrics as an instrumental discipline provides different types of indicators that allow us to know the trends and regularities of scientific activity. Its use is important to evaluate disciplines, institutions, journals, and other scientific aggregates, the results of which are useful both for decision-making and for the generation of new knowledge [8]. As antecedents to this investigation, bibliometric analysis of the second SDG has not been reported in the literature since 2015, which was the official launch year of the SDGs. In a recently published bibliometric report for the region of the Americas, European region, and the Western Pacific region, the SDG 13 (climate action) was the most researched field [9]. As regards international collaborations in the scientific literature based on 17 SDGs, the United Kingdom was linked especially with the United States and Brazil, Canada, India, Mexico, and Switzerland [10]. Therefore, analyses of this type seek to know the participation of countries in research on a topic, observe where the capacities are found, create, and strengthen alliances and carry out projects together.

On the other hand, governments need ideas, and alternative plans to decrease indicators related to famine and poverty, but unfortunately, a global review of the literature finds that most researchers have had wrong priorities [3]. Otherwise, researchers and academics are key players in this context and government authorities should take actions and decisions based on the results and recommendations of its researchers to achieve the SDGs in coming years [3]. According to Taşkin et al. [11], they indicated that the number of publications and citations will increase each year unless there is a change in research evaluation systems.

Therefore, we hypothesize that the scientific production of the original articles (2015–2019) related to “hunger zero” will reflect the investigations and trends in the Pacific Alliance to achieve the second SDG by 2030. Several research questions guided the review.

RQ 1. What is the overall volume, growth rate of published documents across Pacific Alliance countries in “zero hunger” between 2015 and 2019 year?

RQ 2. What journals, funding institutions, organizations or institutions, authors have had the greatest influence on “zero hunger” research?

RQ 3. What is the most frequently studied topics in recent years in the “zero hunger” literature?

RQ 4. What is the state-of-the-art underlying theory and “zero hunger” research?
Materials and methods

Search strategy and inclusion/exclusion criteria

This study was a cross-sectional descriptive analysis of scientific production from the Pacific Alliance related to “zero hunger” literature as SDG of the United Nations. Therefore, the Scopus database was used as a primary source of information. Scopus is widely used in bibliometric studies because it includes a wide range of indexed journals across all fields of scientific literature [12]. The current study was carried out on December 23rd, 2020, and all data analysis, including citation analysis, was carried out on the same day.

The search strategy for “zero hunger”-related literature was carried out based on search terms detailed in the pre-generated queries of Scopus Data Base, and it is stated as: (TITLE-ABS-KEY ( ( {land tenure rights} OR ( smallholder AND ( farm OR forestry OR pastoral OR agriculture OR fishery OR {food producer} OR {food producers})) OR malnourish* OR malnutrition OR undernourish* OR {undernutrition} OR {agricultural production} OR {agricultural productivity} OR {agricultural practices} OR {agricultural management} OR {food production} OR {food productivity} OR {food security} OR {food insecurity} OR {land right} OR {land rights} OR {land reform} OR {land reforms} OR {resilient agricultural practices} OR {agriculture AND potassium} OR fertilizers OR {food nutrition improvement} OR {hidden hunger} OR {genetically modified food} OR {gmo AND food} OR {agroforestry practices} OR {agroforestry management} OR {agricultural innovation} OR {food AND security} AND {genetic diversity}) OR (food market) AND (restriction OR tariff OR access OR {north south divide} OR {development governance}) OR {food governance} OR {food supply chain} OR {food value chain} OR {food commodity market} AND NOT {disease}))) AND (AFFILCOUNTRY ( peru OR colombia OR chile OR mexico)) AND (LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2015)). The meaning and the methodology for using these terms can be consulted and reviewed at https://data.mendeley.com/datasets/87txkw7khs/1 as well as in our Additional file 1. We took this model of search query, which is freely available on Mendeley (https://data.mendeley.com/datasets/87txkw7khs/1). These search terms were updated on November 26, 2020, as it is detailed in the Scopus database [13].

Accordingly, we conducted a literature search for the years 2015–2019. The documents were limited to original articles with at least one affiliation author of the Pacific Alliance countries such as: Mexico, Colombia, Chile, and Peru, without language restriction (Fig. 1). In this bibliometric analysis, only are included original articles, because it reflects the actual research in each country and has probably received some funding from national or international agencies [14], and additionally, the original articles are taken as primary information to make decisions regarding any problem local or global [15].

Bibliometric indicators

The information retrieved from the Scopus database included:

- Annual production of original articles of the Pacific Alliance countries related to “zero hunger”,
- More productive journals,
- Leading institutions, countries, funding agencies, H index of authors, and the most influential original articles cited between 2015 and 2019,
- H index Scopus: a bibliometric indicator that measures the productivity and the impact of the published work of a scientist or academic. Also is defined as the number of papers with citation number higher or equal to h,
- Quartile: position of journals in a category based on SJR values,
- SJR (Scimago Journal Rank): indicator that measures the quality of Scopus journals. One journal transfers prestige to another for the fact of citing it, journals that receive citations from those better positioned, increase the SJR values.

Statistical treatment

Data in Scopus were exported to Excel software for tabulation or mapping and VOSviewer program for mapping purposes [16]. Mapping was made for the most frequently encountered terms in titles/abstracts of the retrieved documents, and the final number of terms was obtained by removing irrelevant terms [17] and for countries with a minimum contribution of 20 documents to visualize international research collaboration in SDG 2.

Results

Volume and annual growth of publications by documentary typology

The search query found 2734 documents of the Pacific Alliance countries between 2015 and 2019. Most citable documents were research articles (n = 2215; 81.0%) followed by review articles (n = 204; 7.5%) and book chapters (n = 132; 4.8%). In the followings analysis, all results were based on the original articles.

The average percentage of the annual growth rate of original articles showed in Fig. 2 was 12.62%. The number of original articles showed an active increasing in 2016,
which had the best annual growth rate with 21.11%. The two major languages of the publications were English ($n = 1813; 81.85\%$) and Spanish ($n = 441; 19.9\%$). In Fig. 3, it is observed that Mexico is the leading country in producing original articles related to “hunger zero”, followed by Colombia, Chile, and Peru.
As is indicated in Table 1, Rahut Dil Bahadur, researcher of the Centro Internacional de Mejoramiento de Maiz y Trigo, from Mexico (2014–2020) was the most active author ($n=27; 1.22\%$) in the number of “zero hunger”-linked publications. Furthermore, eight authors belong to this institution followed by two authors from the Centro Internacional de Agricultura Tropical (Colombia), one author of the University of Talca (Chile), and The Pontificia Universidad Católica del Peru, respectively.

The Universidad Autónoma de Mexico, a public university ranked first ($n=177; 7.99\%$) in the number of “zero hunger”-related publications followed by the Centro Internacional de Mejoramiento de Maiz y Trigo ($n=146; 6.59\%$) and Centro Internacional de Agricultura Tropical from Colombia ($n=136; 6.14\%$). Four Mexican and Chilean institutions conform the top ten institutions in Table 2, and two out of ten are private institutions such as the Pontificia Universidad Católica de Chile.

### Table 1

Top ten active authors in publishing zero hunger-related literature (2015–2019)

| Rank | Author                  | Affiliation                                                                 | Frequency | % ($N=2215$) | H index* | Times cited* |
|------|-------------------------|----------------------------------------------------------------------------|-----------|--------------|----------|-------------|
| 1    | Rahut, Dil Bahadur      | Centro Internacional de Mejoramiento de Maiz y Trigo, Mexico City, Mexico (2014–2020) | 27        | 1.22         | 17       | 117         |
| 2    | Erenstein, Olaf         | Centro Internacional de Mejoramiento de Maiz y Trigo, Mexico City, Mexico (2015–2020) | 26        | 1.17         | 24       | 2191        |
| 3a   | Govaerts, Bram          | Centro Internacional de Mejoramiento de Maiz y Trigo, Mexico City, Mexico (2005–2021) | 13        | 0.59         | 34       | 4128        |
| 3b   | Läderach, Peter Roman   | Centro Internacional de Agricultura Tropical, Cali, Colombia (2010–2020) | 13        | 0.59         | 23       | 1876        |
| 3c   | Shamah-Levy, Teresa     | Instituto Nacional de Salud Pública de México, Cuernavaca, Mexico (2000–2020) | 13        | 0.59         | 33       | 10,466      |
| 6a   | Challinor, Andrew J     | Centro Internacional de Agricultura Tropical, Cali, Colombia (2013–2019) | 12        | 0.54         | 46       | 8633        |
| 6b   | Hellin, Jon             | Centro Internacional de Mejoramiento de Maiz y Trigo, Mexico City, Mexico (2006–2019) | 12        | 0.54         | 25       | 2078        |
| 8a   | Mottaleb, Khondoker Abdul | Centro Internacional de Mejoramiento de Maiz y Trigo, Mexico City, Mexico (2016–2020) | 11        | 0.50         | 15       | 413         |
| 8b   | Stirling, Clare Maeve   | Centro Internacional de Mejoramiento de Maiz y Trigo, Mexico City, Mexico (2014–2020) | 11        | 0.50         | 23       | 1176        |
| 10a  | Bravo-Ureta, Boris E    | Universidad de Talca, Talca, Chile (1995–2019) | 10        | 0.50         | 21       | 1537        |
| 10b  | Ramirez-Villegas, Julian | Centro Internacional de Agricultura Tropical, Cali, Colombia (2009–2020) | 10        | 0.50         | 25       | 2406        |
| 10c  | Sonder, Kai             | Centro Internacional de Mejoramiento de Maiz y Trigo, Mexico City, Mexico (2012–2020) | 10        | 0.50         | 16       | 874         |
| 10d  | Vázquez-Rowe, Ian       | Pontificia Universidad Catolica del Peru, Lima, Peru (2014–2021) | 10        | 0.50         | 28       | 2246        |

*In ranking, two or more equally active authors were given similar ranks and one position in the rank was skipped

*According to author Scopus profile
and Centro Internacional de Agricultura Tropical from Colombia. Otherwise, 6 institutions have the category of universities.

Peru does not have a representative institution in this top table, but its main institution in publishing is the International Center of Potato (Lima, Peru) (Material Supplementary: Table 1).

**Top ten leading journals**

The Nutrición Hospitalaria, a multidisciplinary journal ranked first \( n = 48; 2.17\% \) in the number of “zero hunger”-linked publications followed by Sustainability \( n = 38; 1.72\% \) and Agriculture Ecosystems and Environment \( n = 27; 1.22\% \). Eight of the top ten active journals were from Europe and two were from Latin America (Table 3). Five journals were Q1 and only one journal did have any classification in the Scimago Journal Rank. The main journal that had a major cites per document was Agriculture Ecosystems and Environment which is Q1, while the lowest journal with cites per document was Agrocienca which is Q3.

**Top ten funding institutions**

As is shown in Table 4, of the retrieved publications, 1123 \( (50.69\% \text{ of } 2215) \) original articles declared receiving funding to carry out the investigation. The most active funding sponsor was CONACYT, Mexico \( n = 161; 14.34\% \) of the Mexican total production). The other funding institutions more representative of each country were FONDECYT, Chile \( n = 66; 6.07\% \) of the Chilean total production), COLCIENCIAS, Colombia \( n = 30; 2.76\% \) of the Colombian total production), and Consejo Nacional de Ciencia, Tecnología e Innovación Tecnológica (CONCYTEC, Peru) only funded 3 original articles with 1.44\% of its total production \( n = 209, \text{ Fig. 2} \) and 0.27\% of the total production \( n = 1123, \text{ Table 4} \).

**Research themes in zero hunger-related literature**

Mapping the most frequent terms in title/abstract fields of documents in the zero hunger-related literature with a minimum occurrence of 30 gave 129 terms distributed in three clusters representing three main research themes, which we only selected the 100 first terms. According to Fig. 4, the first cluster (green) included 22 terms and focused on the following topics arranged alphabetically and being more representative: Adolescent, anthropometry, body mass index, calor intake, diet, food intake, nutrition, malnutrition, nutritional status, obesity, overweight, pregnancy, pre-school child, prevalence, and poverty. The second cluster (Blue) included 28 items and focused on the following topics arranged alphabetically and more representative: animal, bacterium, biomass, chemistry, fertilizer, genetics, metabolism, microbiology, nutrient, nitrogen, and soil. The third cluster (red) included 35 items and focused on the following topics...
| Rank | Journal                                      | Editorial                           | n   | % (N = 2215) | TC  | CPD  | Language | Impact factor<sup>a</sup> | SJR 2019 | Quartil<sup>b</sup> (2019) |
|------|---------------------------------------------|-------------------------------------|-----|--------------|-----|------|----------|--------------------------|----------|--------------------------|
| 1    | Nutricion Hospitalaria                      | Aran Ediciones, SL (Spain)         | 48  | 2.17         | 159 | 3.31 | Spanish  | 0.888                    | 0.259    | Q3                       |
| 2    | Sustainability (Switzerland)                | MDPI                                | 38  | 1.72         | 254 | 6.68 | English  | 2.576                    | 0.589    | Q2                       |
| 3    | Agriculture ecosystems and environment      | Elsevier                            | 27  | 1.22         | 623 | 23.07| English  | 4.241                    | 1.719    | Q1                       |
| 4    | Plos One                                    | Public library science              | 24  | 1.08         | 193 | 8.04 | English  | 2.740                    | 1.023    | Q1                       |
| 5    | Agricultural systems                        | Elsevier                            | 23  | 1.04         | 396 | 17.21| English  | 4.212                    | 1.505    | Q1                       |
| 5b   | Terra latinoamericana                       | Mexican Society of Soil Science (SMCS) Mexico | 23  | 1.04         | 30  | 1.30 | Multi language | n.d  | n.d | n.d                   |
| 7a   | Agrociencia                                 | Colegio de Postgraduados de Mexico (Mexico) | 21  | 0.95         | 17  | 0.81 | Multi language | 0.346 | 0.181 | Q3                    |
| 7b   | Journal of cleaner production               | Elsevier                            | 21  | 0.95         | 417 | 19.85| English  | 7.246                    | 1.886    | Q1                       |
| 9a   | Chemical engineering transactions           | Italian Association of Chemical Engineering—AIDIC | 20  | 0.90         | 42  | 2.1  | English  | n.d  | 0.316 | Q3                    |
| 9b   | Frontiers in plant science                  | Frontier                            | 20  | 0.90         | 254 | 12.7 | English  | 4.402                    | 1.691    | Q1                       |

In ranking, two equally active journals were given similar ranks and one position in the rank was skipped.

<sup>a</sup> According to journal citation reports.

<sup>b</sup> Scimago journal rank.
### Table 4  Top ten active funding institutions in publishing the zero hunger-related literature (2015–2019)

| Rank | Funding institutions                                      | Country       | N  | % (N = 1123) | TC  | CPD |
|------|-----------------------------------------------------------|---------------|----|--------------|-----|-----|
| 1    | Consejo Nacional de Ciencia y Tecnología (CONACYT)        | Mexico        | 161| 14.34        | 885 | 5.5 |
| 2    | Fondo Nacional de Desarrollo Científico y Tecnológico (FONDECYT) | Chile         | 66 | 5.88         | 626 | 9.48|
| 3    | Comisión Nacional de Investigación Científica y Tecnológica (CONICYT) | Chile         | 53 | 4.72         | 317 | 6.0 |
| 4    | United States Agency for International Development (USAID) | USA           | 40 | 3.56         | 528 | 13.2|
| 5a   | Bill and Melinda Gates Foundation                         | USA           | 36 | 3.21         | 586 | 16.3|
| 5b   | National Science Foundation (NSF)                         | USA           | 36 | 3.21         | 436 | 12.1|
| 7a   | Departamento Administrativo de Ciencia Tecnología e Innovación (COLCIENCIAS) | Colombia      | 30 | 2.67         | 140 | 4.7 |
| 7b   | Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) | Brazil        | 26 | 2.32         | 517 | 19.9|
| 9    | European Commission (EC)                                  | UE member states | 24 | 2.14         | 500 | 20.8|
| 10   | National Institutes of Health (NIHs)                      | USA           | 20 | 1.78         | 413 | 20.7|

In ranking, two equally active funding institutions were given similar ranks and one position in the rank was skipped. Funded total documents = 1123 (year: 2015–2019). Since January 1, 2020: the Agencia Nacional de Investigación y Desarrollo (ANID) is CONICYT’s legal successor. COLCIENCIAS officially ceased to function on December 5, 2019, when the Ministry of Science, Technology and Innovation (MINCIENCIAS) was created.

TC total cites, CPD cites per document

### Table 5  Top ten influential original articles in publishing zero hunger-related literature (2015–2019)

| Rank | Authors                   | Title                                                                 | Year   | Journal                          | JIF   | TC   | TC/year |
|------|---------------------------|----------------------------------------------------------------------|--------|----------------------------------|-------|------|---------|
| 1    | Asseng S, et al. [18]     | Rising temperatures reduce global wheat production                  | 2015   | Nature climate change            | 20.893| 669  | 111.5   |
| 2    | Anderson I, et al. [19]   | Indigenous and tribal peoples' health (The Lancet–Lowitja Institute Global Collaboration): a population study | 2016   | Lancet                           | 60.390| 317  | 63.4    |
| 3    | Béné C, et al. [20]       | Contribution of Fisheries and Aquaculture to Food Security and Poverty Reduction: Assessing the Current Evidence | 2016   | World development                | 3.869 | 232  | 46.4    |
| 4    | Béné C, et al. [21]       | Feeding 9 billion by 2050 – Putting fish back on the menu            | 2015   | Food security                     | 2.095 | 219  | 36.5    |
| 5    | Estel S, et al. [22]      | Mapping farmland abandonment and recultivation across Europe using MODIS NDVI time series | 2015   | Remote sensing of environment     | 9.085 | 182  | 30.3    |
| 6    | Garibaldi LA, et al. [23] | Mutually beneficial pollinator diversity and crop yield outcomes in small and large farms | 2016   | Science                          | 41.846| 165  | 33.0    |
| 7    | Liu B, et al. [24]        | Similar estimates of temperature impacts on global wheat yield by three independent methods | 2016   | Nature climate change            | 20.893| 156  | 31.2    |
| 8    | Marrugo-Negrete J, et al. [25] | Assessment of heavy metal pollution, spatial distribution and origin in agricultural soils along the Sinú River Basin, Colombia | 2017   | Environmental research           | 5.715 | 147  | 36.75   |
| 9    | Cuellar-Bermudez SP, et al. [26] | Photosynthetic bioenergy utilizing CO2: An approach on flue gases utilization for third generation biofuels | 2015   | Journal of cleaner production    | 7.246 | 144  | 24.0    |
| 10   | Powllon DS, et al. [27]   | Does conservation agriculture deliver climate change mitigation through soil carbon sequestration in tropical agro-ecosystems? | 2016   | Agriculture, ecosystems and environ- | 4.241 | 132  | 26.4    |

Total documents = 2215 (year: 2015–2019)

JIF journal impact factor (Journal Citation Reports: 2019)

TC total cites
arranged alphabetically and more representative: Agriculture, biodiversity, climate change, crops yield, crops, fertilizer application, food security, food supply, sustainable development, and water quality. Additionally, these terms were correlated with the FAO indicator of SDG-2 in order to establish any relationship between the thematic focused on three indicators as is shown in Table 6. In addition, the top term repetitions were: Agriculture, food security, climate change, fertilizer, child, nutritional status, and malnutrition.

| SDG-2 indicators according to the FAO [28]                                                                 | Terms                                                                                           |
|-----------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| 1 Prevalence of undernourishment                                                                          | Nutritional status, overweight, obesity, child, body index weight, pregnancy                    |
| 2 Prevalence of moderate or severe food insecurity in the population, based on the Food Insecurity Experience Scale (FIES) | Food insecurity, Food security, Food supply, catering service, poverty                          |
| 3 Volume of production per labor unit by classes of farming/pastoral/forestry enterprise size               | Forestry, land use change, small holder                                                        |
| 4 Average income of small-scale food producers, by sex and indigenous status                              | Forestry, alternative agriculture, anthropometry, poverty, pregnancy, age, child, land use     |
| 5 Proportion of agricultural area under productive and sustainable agriculture                           | Adaptive management, sustainable agriculture, fertilizers, water quality, nutrients              |
| 6 Conservation of plant genetic resources for food and agriculture                                       | Genetics, chemistry, soil, sustainable agriculture, biomass, microbiology                       |
| 7 Conservation of animal genetic resources for food and agriculture                                       | Animals, genetics, cattle, sustainable agriculture                                              |
| 8 Proportion of local breeds, classified as being at risk, not-at-risk, or unknown level of risk of extinction | Environmental protection, climate change, Zea mays, maize, wheat, fruits, crops field          |
| 9 The agriculture orientation index for government expenditures                                          | Nutrition surveys, Environmental impact, alternative agriculture, adaptive management            |
| 10 Indicator of (food) price anomalies                                                                    | No terms                                                                                        |
In Fig. 5A, we can visualize that the tendency of research terms is focused on food security and food supply in last year as well as the use of fertilizers and environmental impact. In the density visualization (Fig. 5B), it is noted that other terms such as Agriculture, food security, fertilizer, genetic, adolescent,
malnutrition, nutritional status, wheat, and obesity are the main central themes in the Pacific Alliance.

Active countries and international research collaboration
In regard to the international research collaboration, Mexico (973) had the highest percentage of documents with international researchers followed by the Colombia (528), Chile (380), and Peru (192). Mapping research collaboration in the zero-hunger literature for active countries with at least 20 documents (Fig. 6). The strongest collaboration was between USA and Mexico (link strength = 163) followed by USA and Colombia (link strength = 106) and USA with Peru (link strength = 64). On the other hand, Chile had collaborations with Spain (link strength = 60) and USA (link strength = 69). However, as we can observe Peru and Chile are in the same cluster, while Colombia and Mexico lead other cluster, respectively. Three countries of the Pacific Alliance (Colombia, Chile, and Mexico) had very weak collaborations between them.

Data were included with a minimum of 20 “zero hunger”-related publications. Countries in the center with many connections had the highest research collaboration, while countries at the edge of the map had the least research collaboration.

Discussion
The fundamental principle of SDG-2 is to end hunger, achieve food security, sustainable agriculture, as well as improve nutrition, but this will not be achieved if political and economic changes are not adopted by 2030 [29]. However, the goals of zero hunger are not only focusing on the area of hunger reduction otherwise to include an environmental management, public health, and various associated socioeconomic factors such as adding value to agricultural products and to determine the origin of distortions in the price of these products [29].

Thus, we have that the author Rahut, Dil Bahadur from the Centro Internacional de Mejoramiento de Maíz y Trigo (Mexico), is listed as the most productive researcher in the Pacific Alliance and the institution to which he belongs is committed to the SDG-2 whose politics are producing more with less, adding value to grain production, increasing resilience, improving ecosystem services, and promoting inclusion, but overall focusing on small, medium, and large farmers. On the other hand, the Universidad Autónoma de Mexico (UNAM) is consolidated as the most productive university institution which, in addition to leading in the ranking, is among the 200 universities in the world in the ranking of SDGs of the Times Higher Education. Furthermore, the most productive journal is *Nutrición Hospitalaria*, which has published topics related to malnutrition and its improvement, anemia, and nutritional requirements of women and girls. To all this, the most used search
terms are closely linked to the FAO indicators according to the visualization maps, which allows us to infer that the aforementioned axes such as the environmental and socioeconomic are being carried out, as product of the investigations carried out by countries of the Pacific Alliance and its adopted public politics.

The scientific production in zero hunger of authors with at least one affiliation of the countries of the Pacific Alliance has shown a positive increase in the last 5 years, in a linear and growing way. This finding is similar to Sweileh, who carried out an analysis of the publications related to good health and well-being goal (2015–2019) [9]. According to our results, the institutions involved in the publication of these articles are usually research centers and universities, which have an important role as knowledge-generating entities in the agricultural and food area. Recently, a great number of academic institutions in the world have a plan to reduce the undernourishment with social programs [30], projects, and curricula guided to include the SDGs in some courses, [31]. For instance, the Universidad de Chile and the FAO established an agreement in 2019, to create the Forest Engineering School, technical support for the food processing industry with the Faculty of Agronomy, implementation of training programs in the Agricultural Sciences School, and others in the food security field [32].

Likewise, the Pacific Alliance was created to promote the development among member countries in the commercial sector as well as common aspects such as reducing poverty and inequality, but there are some gaps that can slow down this progress, such as the investment in science and technology and political measures to achieve this goal [33]. On the other hand, within the Pacific Alliance, there is an inequality between its member countries such as Peru, which compared to Mexico, Chile, and Colombia have a greater number of ranked institutions [34] and better researcher and development spending [35]. As is observed, the highest production of articles comes from universities and specialized institutions in agriculture such as the Universidad Autónoma de Mexico and the Centro Internacional de Mejoramiento de Maíz y Trigo (Mexico), respectively, which together other Latin American universities have established agreements and commitments with the FAO, focused on “zero hunger” and the scientific production of these institutions during the last 5 years allows us to understand the current trend of these countries towards 2030.

Additionally, the high proportion of international collaborations found and the consequent interinstitutional collaboration networks led by Mexican, Chilean, and Colombian institutions may partially explain these differences, in spite of having as main strategy internships and exchanges between students and professors in the Pacific Alliance. However, the scientific collaboration of Mexico reported in this study is similar to Meschede et al. [10], which Mexico had a strength link with USA and United Kingdom in the analysis of the global literature of the 17 SDGs. Likewise, it was observed that the most cited articles came from authors of the region with any external author from USA or Europe compared to those papers that only included local authors of the Pacific Alliance countries, and our finding is similar to the reports of Puuska et al. [36], which stated that papers published by the cooperation of authors from several organizations gather significantly more citations than papers authored by authors from one organization [37]. Furthermore, those with international collaboration have a greater impact than papers with national collaborations because of their greater quality and prestige [38].

Finally, the obvious interpretation for researchers in this area is that international cooperation will bring them publications with greater impact. However, it was also noted that according to the origin of funding institutions, the number of citations also varied, overall, institutions not belonging to the Pacific Alliance had a higher citation index than those produced with sponsors belonging to Pacific Alliance such as FONDECYT (Peru), COLCIENCIAS (Colombia), FINCYT (Mexico), FONDECYT (Chile), and CONACYT (Mexico). This could be explained according to the amount of money allocated per project, which was not considered in this research.

Thus, the most influential original article titled the “Rising temperatures reduce global wheat production” authored by Asseng S, et al. [18] was highly cited and had international collaboration with more than 20 authors as well as being published in a journal with high impact factor situated in Q1. It has been reported that the number of authors of a paper is correlated with the paper’s impact, so that the more authors a paper has, the more probably it will be cited, as well as the presence of authors from different disciplines, highly cited authors, and high h-index values [39]. Additionally, this indicator takes the cites as a measure of the influence of the published articles. Articles with high citations are the most important for the generation of new knowledge and although it is a controversial metric, in fact when an article is cited denotes relevance in its field.

Thereby, it is highlighted that within the journals with the highest production of original articles, there is a good proportion of publications that are in quartile 3 (Q3) of Scopus, as Nutrición Hospitalaria, as the most widely used journal of dissemination by Pacific Alliance researchers. This journal open access covers the fields of nutrition and food sciences and publishes in English and Spanish [40]. Next, the journals preferred by the researchers to publish their findings
Conclusion
Given this, it is concluded that the scientific production on “zero hunger” of the Pacific Alliance with at least one author, which published between 2015 and 2019 in journals indexed in Scopus database, had a positive increase in last years, concentrated on specialized institutions in the agricultural area as well as ranked prestigious universities and this information is published in journals belong to Q1, Q2, and Q3; furthermore, highly cited documents come from funding agencies not belonging to the Pacific Alliance and at least one coauthor or leading author from the United Sates of Europe countries. As recommendation, it is necessary further work on the subject from a bibliometric perspective, expanding to other sources and information systems. This study allows to draw research policies and therefore improve public policies on the subject while serving as a guide to the conduct of new studies in SDGs. Indeed, we observed during the analysis gaps such as the case of Peru, which belongs to the Pacific Alliance, but its inclusion has not been possible to improve its production indicators either in collaboration within the region or its contribution to the achievement the second SDG according to investigations related to that. Nowadays, universities also are ranked according to its scientific production related to SDGs and this research could address if those recipient funds are used correctly.

Supplementary Information
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Additional file 1. Additional files of a bibliometric analysis of the scientific production related to “zero hunger” as a sustainable development goal: trends of the pacific alliance towards 2030.

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