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Reflections on a Scientometrical Analysis of Embrapa Brazil Web of Science Articles from 1977 to 2006

Roberto de Camargo Penteado Filho
Antonio Flavio Dias Avila

This article studies, using the technique of bibliometrical analysis, Brazilian Agricultural Research Corporation - Embrapa research centers participation in the journals that were indexed in the Web of Science (WoS) database, from 1977 to 2006. First we analyze the performance of the research centers, followed by the journals which published these articles and finally the partnerships with the institutions that had carried out this scientific work with Embrapa. The results indicated that Embrapa is among the top ten Brazilian institutions to lead in the volume of scientific articles published in indexed WoS journals. They also indicate the relevance of the adoption of goals and results system by an institution of Science, Technology and Innovation and the need to select strategies to establish partnerships, select journals in accordance with the institutional stated mission and standardize theirs authors affiliations, in order to facilitate the identification and improve their scores.

1. Introduction

Bibliometrical analysis of structured texts is becoming an important tool for organizations. It is an instrument for the creation of profiles of the areas of interest, for mapping relationships, topics and teams, for analyzing tendencies and developing innovation indicators (Penteado Filho [1]; Penteado *et al*. [2]).

With bibliometrical analysis of structured texts (Porter & Cunningham [3]) the word, could represent, amongst many other things a concept or theme, an individual or an organization, or even a group of themes, individuals or organizations. The basic assumptions of the analysis model states that if two words appear together in the same document they might be connected. If the same words appear together in many documents there is a relation between them (Porter [4]). It involves one-dimensional statistics (how much and what do the values/words mean), bi-dimensional statistics (when and how to evaluate the relationship between two values/words), multi-dimensional statistics (how and when to measure the relationship between various variables/words) and probabilistic statistics (to detect emerging or atypical patterns of behaviors, or even how these values/words behave) (Lafouge *et al*. [5]; Le Coadic [6]; Callon *et al*. [7]).

Spinak [8] presents Scientometrics as "an instrument of the sociology of science" (p.143) and lists some of its applications: To recognize each discipline's nucleus of periodicals, To evaluate secondary journals coverage; To recognize the actors of the different scientific areas; To assess the appropriateness of information services; To predict trends and tendencies of subjects, themes, and disciplines; To study the evolution of the scientific literature; To measure the productivity of publishers, individual authors, organizations and countries, among others.

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Gregolin *et al*. [9], designate Scientometrics as "the science of all sciences" (p.5) serving to develop methodologies for the construction and analysis of indicators in physical, natural and social sciences. It searches to understand the structure, the progression and the connections among scientists and their disciplines, so as "to establish relationships of the sciences with technological, economic and social development" (p.5). For the purpose, Scientometrics utilizes bibliometrical indicators built from published documents in specialized channels involving innumerous parameters, such as the quality of publications, co-authors, citations, co-occurrence of words and others. Such bibliometrical indicators are an "indirect measure" of scientific research activity and contribute to the understanding of "the objectives of research, the structures of the scientific community, its social, political and economical impact" (p.5).

Among others authors, Gregolin *et al*. [9], Lafouge *et al*. [5], Spinak [8] and Callon *et al*. [7] described three types of indicators for the analysis of scientific production: indicators of production, indicators of citation and indicators of connectivity.

The indicators of production/activity measure the "total sum of the number of publications by type of document (books, articles, scientific publications and reports), by institution, area of knowledge, country" (Gregolin *et al*. [9] p.7). These are quantitative indicators. They do not include, for example, the quality of publications.

The indicators of citation/impact calculate the number of citations received for a specific article. They denote the impact of the authors or articles and its influence or visibility. These indicators are based on the theory developed by Garfield [10] [11] affirming that the impact of the scientific article may be measured directly by the number of times it was cited after its publication. Garfield and his associates also developed specific databases to allow authors' affiliations and citations counts. They are the Science Citations Index Expanded (SCI-EXPANDED), Social Science Citation Index (SSCI) and Arts & Humanities Citation Index (A&HCI), today databases of Thomson Reuters, under the denomination of Web of Science (WoS).

As for the indicators of connectivity/relation, these are related to the co-occurrence of the authors, the co-citations of words, knowledge mapping and networks of relationships and collaboration between authors, institutions and countries. The number of co-occurrences in the publications are calculated thus, "the efforts for scientific collaboration" are measured (Gregolin *et al*. [9] p.7) and "the national, international or regional co-operation in the different areas of knowledge" (Gregolin *et al*. [9] p.7) identified and mapped.

Scientometrical indicators in Embrapa

The Brazilian Agricultural Research Corporation (Embrapa), was founded in 1973. It is today one of the largest institutions of agricultural research in the tropical world. It has 8,275 employees, of which 2,113 are researchers, 25% of these with master's degrees and 74% with doctoral degrees. It operates a budget of US$ 1 billion per annum, 38 Research Centers and 3 Service Units. It is present in almost all the States of the Brazilian Federation and under the most different ecological conditions. Its mission is to provide feasible research and development solutions for the sustainable development of the Brazilian agriculture, to benefit the Brazilian society. Thanks to its agricultural research, Brazil can increase at least three times its actual grain production going from 120 million tons to 350 million tons, using 90 million hectares of land yet not cultivated in its Cerrados (Savannas) region, a place that until 30 years ago was only suitable for cattle breeding. It is becoming today a major grain production region.

Embrapa possesses a series of databases which are used in the various areas of its administration, such as those applied in the area of human resources (SIRH), research projects (INFOSEG), budget and finance (SIAFI), and the performance indicators of the central units and research centers linked to the System of Assessment of Units (SAU), one of the components of the System of Evaluation and Award by Results (SAPRE), implanted in 1996 (Portugal *et al*. [12]). The indicators data used in the evaluation of the performance of all Embrapa were collected by the System of the Administration of Information of the Annual Work Plan (SISPAT), in the 1996-2006 period. As of 2007, SISPAT was substituted by the System of Information and Support to Strategic Decision (SIDE), which is mainly dedicated towards the administration of strategic plans of Embrapa known as PDE (Embrapa Main Plan) and of every research

center, the PDU (Unit Main Plan). Actually the corporation has developed, in April 2008, the fifth cycle of the strategic planning with the elaboration of the V Embrapa Main Plan: 2008-2011-2023.

On evaluating the performance of the research centers, one of the main indicators which have been used, is the number of articles published in indexed journals. Initially, were merely pure and simple the quantity of articles published without any consideration for journals quality. From 2002, an index was considered based on the Qualis system, which was developed by the Coordination of the Assessment of Personnel of Higher Learning (CAPES), from the Ministry of Education. This system is a list of journals considered references in 45 areas of knowledge with a scope of distribution International, National and Local and quality "A", "B" and "C". The sole criteria adopted by CAPES and Embrapa to measure journal quality is its Impact Factor as calculated by the "Journal of Citation Reports". This article analyses the scientific production of Embrapa research centers viewed from the angle of publication of articles in indexed journals in the Web of Science (WoS) database and also from the extend of the collaboration or co-authorship of the network of Embrapa researchers with national and international partners. Most journals were "A" quality among the Qualis system. However, when all Embrapa SAU scientific articles scores are considered, the WoS articles correspond to 30.4% of all scientific articles published by the company.

2. Methodology

On September 27, 2007, a search was carried out in the WoS database, covering a period from 1973 to 2007, for all records, in every language and all types of documents, with mention of "EMBRAPA" in the authors' address.

From this, 5206 records were located. To discard research done before the constitution of the organization the 1974 to 1976 (8 articles) period was not considered. Some 366 records from 2007 were also discarded, resulting into only 4832 articles from a 30 years period.

The Author, Author Affiliation, Country, Publication Year, Publisher, Source and Times Cited fields were standardized and segmented. The Author Affiliation field was divided as follows: Embrapa (type of center and region), Brazil (region), USA/Canada, Europe, Oceania, Africa, Asia, Latin America and UN System. The Publication Year field was divided into 3 decades, 1977 to 1986, 1987 to 1996 to 1997 to 2006, and 6 five-year periods; 1977 to 1981, 1982 to 1986, 1987 to 1991, 1992 to 1996, 1997 to 2001 and 2002 to 2006.

The Source field was divided into Brazilian and foreign journals. The Publisher field was segmented according to geographical regions; Europe, Brazil, USA/Canada, Latin America, Asia, Oceania, Africa. The analysis was centered in the indexed WoS articles produced by Embrapa 37 research centers.

3. Results

The results are presented in 2 blocks. The first describes the characteristics of the production of the indexed WoS articles: the progression of the year to year production, articles by research center, by language, by national and international journals and its publishers. The second block approaches the national and international partnerships established for the production of these articles.

In the first two decades analyzed, the average production of all of Embrapa research centers was, 24.7 articles/year and 78.3 articles/year, respectively. In the 1997-2006 period, production grew almost 5 times reaching a production average of articles published in the WoS, of 391.3 articles/year. The mean production in all periods was 161.06 articles/year.

3.1 Articles by year

In the first 20 years of Embrapa, the publication of scientific articles did not present a uniform distribution, and only achieved its peak in the 1981-1982 period. It was only in 1992 that the number of 73 articles published in 1981 was overcome. In 1993, this superseded 100 articles/year. From that date, the publication initiative sprinted. In 1997 this reached more than 200 articles/year, in 1999, more than

300 articles/year, in 2003, more than 400 articles/year and in 2006, more than 500 articles/year, which placed Embrapa among the top ten scientific institutions in Brazil.

Therefore, its important to note that as of the early 1990s, through the initiative of the Brazilian Ministry of Agriculture, Livestock and Supply (MAPA), the demand for an annual production of articles by the research centers began. Embrapa then included in its Annual Report of Activities the scientific production from each of its centers, as well as technology generation and transfer. Such a process was structured beginning 1996, when Embrapa created the SAU system and determined annual quantitative goals such as the publication of scientific articles in indexed journals. This process of assessment was adapted to a system of awards for results, which inspired the research centers to increase their production of the items of performance indicators used, particularly, published articles in indexed journals, which is the object of this study. Figure 1 below shows the progression of the production of scientific articles registered in September 2007, in the WoS database from 1977 to 2006.

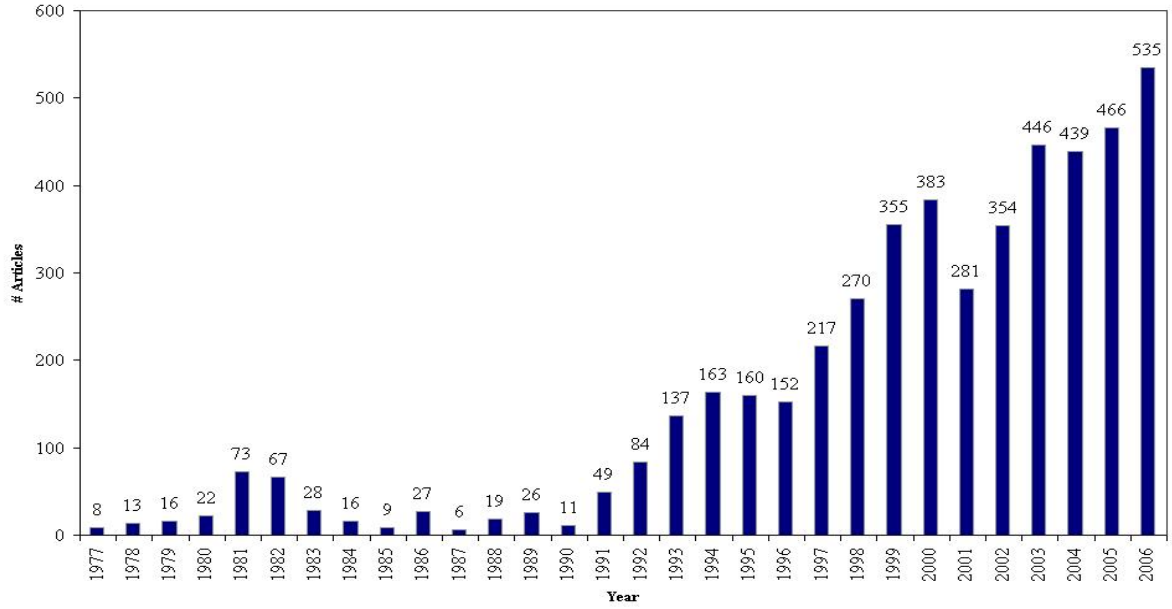

Figure 1. Scientific articles published by Embrapa in Web of Science indexed journals, 1977 to 2006.

3.2 Articles by research centers

Table 1 allows us to analyze the ten research centers with the largest number of articles published in the WoS over the last ten years. Compared to the other centers, there is a differentiated pattern in Embrapa Genetic Resources and Biotechnology in the 1997 to 2006 period. This center registered, from 1999, a spectacular increase in the number of articles published, bypassing the other units, surpassing the 40

Table 1. Progression of the production of articles per year - Top 10 research centers, 1997-2006.

Embrapa	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Genetic Resources and Biotechnology	28	22	42	60	43	64	79	65	77	71
Agrobiology	15	11	12	16	15	11	16	25	24	39
Dairy Cattle	19	16	29	26	23	19	21	22	31	32
Soya	18	20	12	21	15	16	24	18	26	43
Cerrados (Savannas)	16	11	17	20	6	14	23	28	23	25
Rice and Beans	13	15	12	14	23	21	20	15	15	19
Agricultural Instrumentation	11	13	15	14	18	17	27	24	21	22
Corn and Sorghum	8	12	19	16	10	16	20	12	17	19
Beef Cattle	11	10	10	19	14	20	23	17	20	23
Cattle Southeast	8	14	17	16	15	19	15	21	32	20

articles/year average, and almost reaching 80 articles/year. It was only in 2006 that another center, Embrapa Soya, attained the 40 articles/year average. The majority of the first ten centers under analysis, published 10-30 articles/year in the last decade. The other centers are: Agrobiology, Dairy Cattle, Cerrados (Savannas), Rice and Beans, Agricultural Instrumentation, Corn and Sorghum, Beef Cattle and Cattle Southeast.

The other 27 research centers presented an average production ranging between 0.36 and 6.6 articles/year during the three decades but, like the first 10, also registered an accentuated growth in the last decade.

Embrapa segments its research centers in four groups: Thematic (that work with specific knowledge themes and subjects), Animal Products (technological references to certain animals), Vegetal Products (technological references to certain plants), Eco-regional (technological solutions for the different national eco-regions sustainable development). The article production by center type was the following:

- Nine thematic centers produce 33.07% of all articles,
- Nine vegetal products centers produce 26.42%,
- Thirteen eco-regional centers produce 21.64% and
- Six animal products centers are responsible for 18.87% of all articles.

3.3 Articles by languages

The production of articles in English is an important pre-requisite to enable its publication in an international periodical, in any activity or area of research. Thus, the percentage of articles in English is an indicator of the growth of the publication activity of a research center and also its international exposure. Thirteen of Embrapa research centers published more than two-thirds of its articles in English: Genetic Resources and Biotechnology, Soya, Agrobiology, Agricultural Instrumentation, Environment, Horticulture, Eastern Amazon, Food Technology, Pantanal, Forestry, Agriculture Informatics, South Animal Husbandry & Sheep and Satellite Monitoring. Six of them are among the 13 centers which published above Embrapa average. Eleven research centers published a major part of their research in Portuguese. They are: Cattle Southeast, Dairy Cattle, Swine and Poultry, Wheat, Tropical Semi-Arid, Cotton, Goats and Sheep, Coastal Tablelands, Western Region Agriculture, Rondonia and Amapa.

Segmenting the centers by type it was shown that Thematic centers produce 82% of their production in English while Animal Products centers have 57% of their production in Portuguese. Vegetal Products and Eco-Regional centers produce respectively 61% and 52% of their articles in English.

3.4 Articles by Journals

Embrapa and its partners' articles were published in 723 journals, of which 694 are foreign and 29 national. In spite of representing only 4% of the journals, the national journals published practically 50% of the articles. Table 2 shows this synthesis:

Table 2. Embrapa articles published in the WoS according to the journals origins.

Articles Published	Number Of Journals	%	Number Of Articles	%
Articles In National Journals	29	4,01	2390	49.46
Articles In Foreign Journals	694	95,99	2442	50.54
Total	**723**	**100**	**4832**	**100**

There is, in addition, a concentration of articles publication in a limited number of journals and also in Brazilian journals. It was ascertained that, considering only the first 25 from the 723 journals, 14 of which are Brazilians, these published practically 50% of the articles (49.92%). Furthermore, it was also identified that a major part of Embrapa research centers publish practically one-third of its articles in the agricultural Sc. &T journal published by the company itself. Those tables are not shown.

Considering the center types we found that only the nine Thematic centers publish 72.02% of their articles in foreign journals. All the other types publish more than 50% of their production in national journals. Animal Products centers publish 69.76% of their production in Brazil edited journals. Table 3 shows these numbers.

Table 3. Embrapa articles by type of center according to the journals origins.

Embrapa By Type Of Research Center	Foreign Journals	National Journals	Total	% National	% Total
Thematic (9)	1156	449	1605	27.98	33.07
Vegetal Products (9)	604	678	1282	52.89	26.42
Eco-Regional (13)	453	597	1050	56.86	21.64
Animal Products (6)	277	639	916	69.76	18.87

3.5 Articles by publishers

The European publishers published 36% of the articles while the American and Canadian published 13% of the articles. In the last ten years there has been a significant growth in the publication of articles by European publishers, but this changed in 2006, where there was a 38.3% increase of publication with Brazilian publishers. The journals from US publishing houses presented a decrease since 2003 while the journals in the other continents have yet to reach a significant figure. Observe the details in Table 4.

Table 4. Progression of article publication per year by the publishing houses in the world regions, 1997-2006.

Region	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Brazil	110	151	201	211	122	154	200	181	188	260
Europe	75	73	108	121	118	145	180	194	210	208
Usa/Canada	25	42	41	44	37	48	63	56	50	60
Oceania	5	1	0	3	2	3	2	4	11	5
Latin America	1	1	2	1	1	1	1	1	3	0
Asia	1	2	3	3	0	3	0	3	4	2
Africa	0	0	0	0	1	0	0	0	0	0

Although Brazilian journals have increased the publication of other languages than Portuguese articles, 71% of the 260 - 2006 articles were written in Portuguese. The other 29% were in English.

The increase in the number of publications by Embrapa in Brazilian journals from 2005 to 2006 was triggered by 9 journals which published 97 articles in 2006. The main one is Pesquisa Agropecuária Brasileira (PAB) with 56 articles, or 58% of those items. It was detected that the rise in articles published in Brazilian journals was also due to the addition of new Brazilian journals since 2003 by Thomson Reuters WoS. These new journals added, in 2006, 49 articles to Embrapa score of 260 articles in Brazilian journals. Foreign journals contributed with 275 articles to Embrapa total score of 535 articles in 2006.

This finding punctuates a strong pre-existent flux of scientific articles among Brazilian journals concerning agricultural research. Since most of these journals publish eminently in Portuguese, the flux detected concerns mostly Brazilian scientists, Brazilian science and, we must presume, Brazilian interests.

3.6 Partnerships by institutions

Indicators to evaluate national and international partnerships gain importance when studied in its entirety; the total number of scientific journals, the number of Brazilian scientific journals, the number of articles published in English and Portuguese, the number of international and national partners (co-authorships) and the number of partnerships in the world by geographical regions.

Table 5 shows the evolution of publication activity of scientific articles of eleven main partners in the last 10 years. All are Brazilian universities. The growth of the relative importance of the University of Sao Paulo (USP) was significant as of 2001. This particular data is an addition of all USP Departments that were discriminated in the dataset. It does not add up to the total scores. It is also important to note the rising cooperation with University Federal of Viçosa (UFV) and an USP Department, the School of Agriculture Luiz de Queiroz (USP-ESALQ*) from 2003. Others USP Departments such as University of Sao Paulo at Sao Carlos, are identified with an asterisk such as USP-SC*. Other partners' names are in Annex 1.

Table 5. Progression of the main partnerships from 1997 to 2006.

Partners	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
USP	13	15	23	28	15	30	71	117	80	71
UFV	7	24	30	16	14	16	52	25	35	42
USP-ESALQ*	2	4	6	9	2	9	26	32	38	30
UNESP	3	4	6	13	13	19	25	27	28	27
UNB	5	5	13	10	14	18	21	30	32	26
UFMG	13	9	9	11	8	13	24	16	15	23
UFRGS	3	2	1	7	3	9	6	9	18	22
UFRJ	3	6	4	7	8	9	10	10	19	21
UFRRJ	7	4	7	8	8	3	8	16	12	20
USP-SC*	8	7	8	10	9	8	15	17	14	17
UNICAMP	3	3	4	5	2	6	15	20	15	15

3.7 Partnerships by geographical and local groups

Table 6 shows Embrapa scientific production divided by geographical and local groups per five-year period. The articles generated 8435 partnerships in the form of co-authorships. There were 4663 co-authorships within Embrapa and 3772 with external partners. Also relevant is the partnership with Brazilian organizations. These added to those within Embrapa represent 82% of all co-authorships. This and the fact, that the ten main partners over the last ten years are all Brazilian universities, confirms that agricultural research in Brazil is strongly nationally oriented.

In the last 5 years, Europe bypassed the United States and Canada, as Embrapa major international partner. Partnership with Asia, Oceania e Africa also increased notably. However, the partnerships with the rest of the world (Latin America, Asia, Africa e Oceania) added to 2.96% of all co-authorships. In spite of a growth tendency, this still is a residual figure in Embrapa international partnerships. The cooperation with the United Nations Agricultural Research System (UN SYSTEM) organizations grew within the period although at a lesser rate compared to other segments being studied.

The following is a study of the partnerships by regions of the world: United States and Canada; Europe, Africa, Latin America, Asia and Oceania. The tables show the number of articles published, in 5-year periods, from 1992 to 2006.

Table 6. Main partners of the published articles by geographical regions in the world, by 5-year periods.

Partners	1977/1981	1982/1986	1987/1991	1992/1996	1997/2001	2002/2006	Total	% Total 1	% Total 2
Brazil	40	20	20	120	585	1492	2277	60,37	26,99
Usa/Canada	15	9	16	79	190	298	607	16,09	7,20
Europe	8	5	9	56	164	307	549	14,55	6,51
Latin America	1	0	0	11	22	68	102	2,70	1,21
Un System	3	6	3	14	28	36	90	2,39	1,07
Asia	4	2	0	7	11	38	62	1,64	0,74
Oceania	2	1	1	6	16	33	59	1,56	0,70
Africa	1	0	0	3	7	15	26	0,69	0,31
Total 1	**74**	**43**	**49**	**296**	**1023**	**2287**	**3772**	**100,00**	**-**
Embrapa	122	133	102	670	1459	2177	4663	-	55,28
Total 2	**196**	**176**	**151**	**966**	**2482**	**4464**	**8435**	**-**	**100,00**

Below are listed Embrapa first ten partners in the United States and Canada (Table 7) and in Europe (Table 8). It is not by chance, the first partners in the USA/Canada and the first two in Europe are the headquarters of Embrapa Overseas Virtual Laboratory: Agricultural Research Service from the United States Department of Agriculture (USDA-ARS), France's institutions of agricultural international cooperation, the Center of International Cooperation for Agricultural Research and Development (CIRAD), the Institute of Research for Development (IRD/ORSTOM) and the University of Wageningen (UWAGENINGEN), in the Netherlands. Other partners' names are in Annex 1.

Table 7. Top 10 partners in the USA and Canada 1992-2006.

Partners	1992/1996	1997/2001	2002/2006
USDA-ARS	21	36	83
UFLORIDA	6	26	31
UCAL	9	26	22
UCORNELL	11	16	22
UWISCMAD	5	15	14
AAFCAN	3	7	11
UPURDUE	2	1	16
UNEBRASKA	5	5	10
UGEORGIA	0	1	12
TEXASAM	5	4	6

Table 8. Top 10 partners in Europe 1992-2006.

Partners	1992/1996	1997/2001	2002/2006
CIRAD/IRD/ORSTOM	0	13	58
UWAGENINGEN	1	14	31
INRA	4	7	19
UBAYREUTH	0	19	10
ROTHAMST_CABI-UK	3	12	9
UEDINBURG	0	3	24
ULONDON	2	11	8
UCATLOUVAIN	6	4	10
UGOTTINGEN	0	4	12
UHAMBURG	0	5	9

Partnerships with the rest of the world are mainly found in Australia's Commonwealth Science and Industry Research Organization (CSIRO), Argentina's Instituto Nacional de Tecnologia Agropecuaria (INTA), Mexico's Universidade Nacional Autonoma do Mexico (UNAM) and Japan's Japan International Research Center for Agricultural Sciences and National Agricultural Research Center (JIRCAS/NARC). See Table 9. Other partners' names are in Annex 1.

Table 9. Top 10 partners in the rest of the world 1992-2006.

Partners	1992/1996	1997/2001	2002/2006
CSIRO-AUS	4	7	18
INTA-ARG	5	4	9
UNAM-MEX	2	4	10
JIRCAS/NARC-JAP	2	0	9
PROJFLOR-PER	0	0	8
AGRCFR-NZ	0	3	4
UNACCUZ-PER	0	0	7
ACSC-CHINA	0	2	4
UQUEENSLAND-AUS	1	2	2
UBUENAIRES-ARG	1	1	4

4. Main findings

The main study result is the confirmation that Embrapa is one of the leading institutions in Brazil in terms of scientific production. Leta *et al*. [13] placed Embrapa at the 8th place among Brazilian scientific institutions in the 1991-2003 period. Other country rankings only concerned scientific production by Brazilian universities in the WoS, or dealt with Embrapa only partially (Gregolin *et al*. [9]; Leta & Cruz [14]). With the results obtained here, one can compare the production of scientific articles by Embrapa, in the 1977-2006 period with other national institutions of S&T. In the 2000-2005 period, for example, Embrapa published 2,369 articles placing the institution at the 8th place comparing with a ranking of Brazilian universities, as published in January 14, 2008, at Folha de S. Paulo newspaper (Gois [15]): USP (17,945), UNICAMP (7,207), UFRJ (6,494), UNESP (5,316), UFRGS (4,158), UFMG (3,674) and UNIFESP (2,533). Next universities in the list are: UFSCAR (2,290), UFSC (1,878) and UFPR (1,802). The universities names are in Annex 1.

The analysis of the articles production from year to year, also shows that in 1990, when a system of evaluation and awards for results started to operate, the number of published articles grew significantly, even contrasting with the development of the production registered in previous years. As of 1996, when Embrapa established the SAU performance evaluation system, with annual quantitative goals for diverse items, amongst which are scientific articles at indexed journals, the company's article output grew up continuously. The significant and sustained increase in the production of articles in indexed journals in the Web of Science, verified from 1997 to 2006 contrast with the performance of the previous periods and it coincides with the period where SAU was adopted.

In addition, the study allows us to observe the partnerships between Embrapa and other national and foreign institutions progression and focus on the main partnerships in Brazil and in the world. It is more concentrated in few partners than expected or presumed. Still is interesting to register the growth of cooperation with Europe in the last 5 years including taking the traditional second place of the co-operation with the United States and Canada. The evidence that co-authorships within Embrapa and with Brazil count for 82.27% of all articles is linked to the fact that in Brazil, Agricultural Research is a main national scientific area. This is clearly shown by the publication numbers: Although only 29 (4.01% of the total number of journals), the Brazilian journals publish 49.46% of the articles. Foreign journals represent 95.99% of all journals but 50.54% of all articles.

The parallel fluxes of articles written in the Portuguese language and published in Brazilian journals and written in English published in foreign journals express the different missions and main stake holders of Embrapa research centers. Thematic centers are dedicated to frontier areas of knowledge and to a more international public such as Genetic Resources and Biotechnology, Agrobiology, Environment and Agricultural Instrumentation. They publish mostly in English and in foreign journals. Others such as Animal Products centers-Dairy Cattle, Beef Cattle, Swine and Poultry-, or Eco-regional centers such as Coastal Tablelands, Rondonia and Amapa, are focused on developing technologies aiming national, regional or even state development and their main stake holders-considering who their research will benefit first - are more Brazilian oriented. So they publish mostly in Portuguese and in Brazilian journals. This statement is also supported by the consideration that in the same time period, WoS articles concern only 30% of all articles published by Embrapa as far as SAU numbers are considered. All these other SAU scientific articles were written in Portuguese and published in Brazil.

This study demanded an enormous effort for the standardization of data, as it is a norm in bibliometrical research. As an example, the 634 articles published by Embrapa Genetic Resources and Biotechnology research center, have 533 different forms for denominating this research unit. For that, a pre-standardization initiative of authors' basic information, for instance, theirs affiliations, by their own scientific and technological institutions such as Embrapa and others that practice scientific activities and publish indexed articles in international databases, would be most welcome. This would have facilitated the localization of these articles and its counts and recovery by third parties, which means attaining bigger chances of better scores and rankings.

5. Conclusion

The data suggests that the flux of articles in Portuguese published in Brazilian journals is pre-existent and is much larger than shown in WoS. Data also points out that WoS based indicators can be a weak measure of the state of the art in a nationally oriented area of science, for countries like Brazil, that are less represented in the database.

These findings corroborate Penteado Filho's conclusion that "scientific production indicators show who publishes most, in the selected period, on the journals indexed in the database from which the data was extracted to compose the indicators" (Penteado Filho [16] p.239).

Institutions that establish policies of Superior Education and of Science, Technology and Innovation should consider the counter effect on national development that single WoS based indicators can have on nationally oriented research areas such as agricultural research. Researchers would then be encouraged to dislocate their flux of articles to other languages and journals where their research could be ignored, whenever published.

Considering these limitations of measurement, it looks more rational for these WoS "misrepresented" countries to focus their evaluation systems on the consistence of an institution mission and scientific production instead of focusing on scientific production indicators all alone. Also, including the beneficiaries of an institution actions in an evaluation equation will have effects on determining the best language and journals that cover that stake holder. That will allow these institutions to develop all their potential while fully inserted in their realities.

This study also points to the virtues of multidimensional evaluation systems of Sc,T&I institutions that are aligned with the superior administration priorities, such as Embrapa SAU.

Although it has become an international reference in tropical agriculture, Embrapa international partnerships out of the United States, Canada and Europe respond for less than 3% of all articles. To sustain the company image and its scientific production requires the adoption of specific policies to increase cooperation with other continents, including those such as Africa and Latin America that would be direct beneficiaries of Brazilian agricultural technologies. Among the new welcome policies, encouraging production of bilingual articles - Portuguese and English - would be a must.

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Annex 1. Names of other institutions cited

AAFCAN	Agriculture and Agri-Food Canada
ACSC_CHINA	Academy of Sciences of China
AGRCFR-NZ	Agricultural Research New Zealand
INRA	Institut National de Recherche Agricole - France
PROJFLOR-PER	Project Flora Peru
ROTHAMST_CAB-UK	Rothamstead Research Institute/Commonwealth Agricultural Bureaux - United Kingdom
TEXASAM	Texas A&M University - USA
UBUENAIRES-ARG	University of Buenos Aires - Argentina
UBAYREU	University of Bayreuth - Germany
UCAL	State Universities of California - USA
UCATLOUVAIN	Catholic University of Louvain - BEL
UCORNELL	University of Cornell - USA
UEDINBURG	University of Edimburg - UK
UFLORIDA	University of Florida - USA
UFMG	University Federal of Minas Gerais - Brazil
UFPR	University Federal of Parana - Brazil
UFRGS	University Federal of Rio Grande do Sul - Brazil
UFRJ	University Federal of Rio de Janeiro - Brazil
UFRRJ	University Federal Rural of Rio de Janeiro - Brazil
UFSC	University Federal of Santa Catarina - Brazil
UGEORGIA	University of Georgia - USA
UGOTTINGEN	University of Gottingen - Germany
UHAMBURG	University of Hamburg - Germany
ULONDON	University of London - UK
UPURDUE	University of Purdue - USA
UNACCUZ-PER	University National of San Antonio Abad, Cusco - Peru
UNB	University of Brasília - Brazil
UNEBRASKA	University of Nebraska - USA
UNESP	State University Paulista - Brazil
UNICAMP	State University of Campinas - Brazil
UNIFESP	University Federal of Sao Paulo - Brazil
UQUEENSLAND-AUS	University of Queensland - Australia
UWISCMAD	University of Wisconsin-Madison - USA