Scientometrics, Vol. 23. No. 1 (1992) 137-148

COOPERATIVE RESEARCH PROJECTS BETWEEN THE SPANISH NATIONAL RESEARCH COUNCIL AND LATIN-AMERICAN INSTITUTIONS*

M.T. FERNÁNDEZ, A. AGIS, A. MARTÍN, A. CABRERO, I. GÓMEZ

Instituto de Información y Documentación en Ciencia y Tecnología (CSIC), Joaquín Costa 22, 28002 Madrid (Spain) +

(Received February 8, 1991)

Research projects in cooperation between Spanish National Research Council and Latin-American Organizations, that have been developed in the last eight years, were studied. Around forty Spanish research institutes have cooperated with Latin-American ones, mostly with Cuba, Chile, Brazil and Mexico. The interpretation of the collaboration rates with the different countries is discussed. Duration of the projects, number of researchers and research output were examined. The cooperation results were quantified through articles, presentations to congresses, reports, monographs, patents and thesis. Diffusion, languages and impact of the journals used for publication were studied. Non quantifiable outputs were also examined.

Introduction

Presently there is a great interest on research projects in cooperation, both North-South cooperation, regional cooperation or with developing countries, as collaboration is considered to enhance quality of the research results and help diminish the technological and scientific gaps. There is a need to measure and evaluate the effects of this cooperation, what benefits it reports, both tangible and intangible. The tangible effects can be evaluated quantitatively and qualitatively while the intangible ones, like the socio-economic effects of cooperation, are more difficult to measure.

International collaboration in research can be estimated through different partial indicators: as number of researchers exchanged between two countries, number of fellowships for foreign researchers, exchanges of ideas at congresses, dissertations, co-authored papers, etc. This latter indicator is the easiest to obtain through those bibliographic databases that record all the authors and their institutional addresses:

*Paper presented at the International Conference on Science Indicators for Developing Countries, Paris, 15-19 October, 1990.

+Author for correspondence: *Isabel Gómez,* ICYT (CSIC), Joaquín Costa, 22 28002 Madrid, Spain.

the *Science Citation Index* as multidisciplinary and some other subject-oriented databases like Physics Briefs or INIS. Nevertheless, two important shortcomings have to be kept in mind when using this indicator: (a) the number of multinationally authored papers is only a partial indicator that shows an apparently equivalent contribution of both cooperating countries, which is not always the case, and (b) the validity of the results obtained especially for less developed countries is limited in accordance to the local publications' coverage by the database used, which is very low in the case of SCI.[1]

Co-authoring of scientific papers between different sets of countries was studied by *Frame* and *Carpenter*[2] using the SCI database, and later by *Schubert* and *Braun*[3] and by the French LEPI group.[4]

Quality of the resulting publications is difficult to determine, being peer review the method traditionally used. Other controversial indicators relate quality to the impact factor of the publication journal or to the number of citations received by the article itself. Both these indicators depend on the opinion of the international scientific community and can be considered as a measure of visibility or impact of mainstream science. Local publications, dealing with non mainstream problems, should be evaluated differently. When analysing the number of citations received by multiauthored publications, *Narin* observed[5] that impact increased from single- to multiple-institution papers, and doubled in the case of multinational papers.

The EC is promoting scientific cooperation projects in Europe to try to foster the development of less favoured regions. Indicators applied are number of co-authored papers between research of different countries, study of the factors determining this cooperation and impact of the resulting publications. In the case of EC agricultural research projects, indicators for science policy evaluation used were international co-authorship in scientific publications and awareness of scientists through citations.[6]

Another aspect studied is whether cooperation takes place in those subjects of direct interest for the peripheral countries or if it follows the central countries interests. This was studied by one of us in the case of OECD cooperation in Physics.[7]

The Spanish National Research Council (CSIC), a research institution that covers very different areas of knowledge, has established scientific agreements with many different countries and in many cases they have acted as a frame for the development of joint research projects. Among these projects, those with Latin-American countries present a special interest due to our common culture and language. Recently the CSIC has decided to create a database with the on-going cooperative research projects with Latin-American countries in the last eight years. It contains

information on the subject of the projects, summary and objectives, countries involved, institutions, scientific personnel, duration of the projects and different outputs obtained, as well as quantitative data on benefits derived from the joint projects and problems found. This database will be a useful tool to study scientific cooperation between different institutions and countries, to determine which disciplines are involved, as well as to analyse the results obtained from the cooperative effort.

At present, no evaluation of the results of the projects is being made, as the results obtained are not compared with the projects goals nor the economic and material resources involved. This will be only a first series of data and analysis obtained from the 94 projects now included in this new database, that can be used in the future by science policy makers.

Methodology

The data on the cooperative projects between Latin-American institutions and CSIC have been obtained by its International Department through sending a questionnaire to the principal Spanish research responsible for the projects. Full information from the Spanish side of the projects was thus obtained. With the results of the questionnaires several related files in DBaseIV were created.

Analysis of the project input data

Countries

The Latin-American countries involved in the projects are shown in Table 1. The country with which more projects have been developed is Cuba (26 projects), followed by Argentina with 21, Chile with 20, Brazil and Mexico with 13 each and Colombia with 1 project.

Institutions

The Spanish institutions are mostly institutes belonging to the CSIC, joint centers university-CSIC or some university departments sponsored by the CSIC. As a whole, 38 Spanish institutions are responsible for the 94 joint projects. In Table 2 the most

active of them are shown: the Institute on Catalysis, with ten projects, followed by centers working on Earth Sciences and Agrochemistry.

As for the Latin-American institutions involved, they depend on how research is organised in each of the countries: they are mostly Universities, National Research Councils or Ministries in the case of Cuba (Table 3).

Table 1
Countries participating in the projects

Country	No. of projects
Argentina	21
Brazil	13
Chile	20
Colombia	1
Cuba	26
Mexico	13

Table 2
Spanish institutions responsible for 4 or more projects

Spanish institutions	No. of projects
I. Catálisis y Petroleoquímica	10
Estación Exp. "El Zaidín"	7
I. Agroquím. y Tecn. Alimentos	6
C. Investigación y Desarrollo	6
I. Edafología y Biol. Vegetal	5
C. Investigaciones Biológicas	5
C. Nac. Invest. Metalúrgicas	4
Museo Nac. Ciencias Naturales	4

Scientists

The number of scientists participating in the projects, according to the data obtained, was 327 Spanish scientists and 363 from Latin America. The mean number of scientists per project was around seven. In some cases, the same people participate in several projects along the eight year period studied: one Spanish scientist took part in 5 projects, two in 4 projects, one in 3 and eight scientists took part in 2 projects each.

Table 3
Latin American institutions participating in the projects

Country	University	Acad. or Res. Council	Joint Centers	Ministeries	Others
Argentina	2	9	8	1	1
Brazil	10	3	–	–	–
Chile	20	–	–	–	–
Colombia	1	–	–	–	–
Cuba	7	2	1	16	–
Mexico	10	3	–	–	–

Time length

All the 94 cooperation projects analysed have started along the past eight years, with a clear increase from 1986 onwards: as can be seen in Fig. 1, 14 projects started in 1986, 16 in 1987, 20 in 1988 and 17 in 1989.

The mean length of the projects has been of around four years, although this parameter changed a lot: the longest project has been developed along the whole time-period studied, while there are others that have just started in 1990.

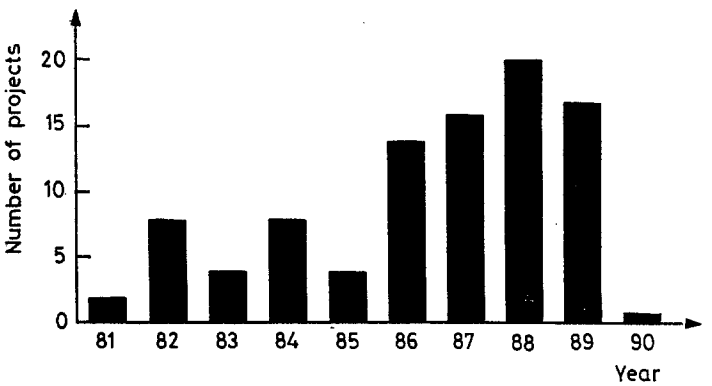

Fig. 1. Starting year of the projects

Subject

According to the UNESCO subject classification,[8] 90 of the 94 joint projects were included in science and technology scientific fields, while only four belonged to social science and documentation, as shown in Table 4. As a rule, all of the countries involved had projects in the technological sciences and all but one in physics.

According to the type of research, technology, agriculture and earth sciences represent very applied and local interests, while physics and life sciences are mainstream subjects. The low figure for medical projects is due to the lack of this research activity in the CSIC.

Table 4
Distribution of the projects by scientific field

Scientific field	No. of projects
Technology	20
Physics	16
Life sciences	16
Earth and space sciences	14
Chemistry	11
Agriculture	6
Mathematics	4
Social sciences	4
Astronomy	2
Medicine	1

We tried to analyse if any correlation existed between scientific potential of Latin-American countries and their cooperation rate with the CSIC. The scientific output of the countries involved was obtained from two multidisciplinary database in science and technology: the international database SCI and the Spanish databases ICYT (Table 5). With these databases we could only obtain a limited view of Latin-American scientific output, as SCI records only mainstream science and ICYT only Spanish journals in science and technology: thus no local publications are detected. No good correlation for the total data was found, but the four countries with a higher number of publications in SCI, Brazil, Argentina, Mexico and Chile, have quite an important number of cooperation projects too, as could be expected. The absence of Venezuela is striking, considering its research output. The case of Cuba is quite different: in spite of its small production in the SCI it is the country with more projects with the CSIC.

The scientific production of these countries in the ICYT database is different: Brazil has very small number of papers, probably due to language barriers, as the database covers only Spanish journals, while Cuba has greater production than Mexico.

Table 5
Comparison between projects and papers recovered by two databases

Country	No. of projects Sci. & Techn.	No. of publications SCI 81-89	No. of publications ICYT 80-88
Argentina	21	14311	418
Brazil	13	17945	45
Chile	20	7831	215
Colombia	1	864	22
Cuba	26	711	108
Mexico	13	8682	94

The distribution of the cooperation projects is influenced partly by the scientific potentiality of the countries involved and partly by human and historical factors, for example scientists with greater interest in cooperating with foreign colleagues. The political isolation of Cuba from its strong neighbour, the USA (the most frequent partner of Latin America in co-authored papers), has probably enhanced its cooperation with Spain and its publishing in Spanish journals.

Output data

The output quantifiable results obtained from the cooperation projects have been grouped under the following headings: scientific papers, contributions to congresses, reports, monographs, patents, dissertations and conferences. Under the contributions to congresses both abstracts and proceedings have been included; thesis include both master and PhD dissertations; conferences include several long specialized courses.

Most of the results obtained are scientific papers (435) followed by contributions to congresses (333), as shown in Table 6. The results related to teaching are quite abundant: 156 conferences and courses and 46 dissertations have been produced. Several projects were specifically aimed to the organization of specialized international courses: two with Mexico on agricultural chemistry and computer science, others with Brazil and Cuba on molecular pharmacology.

Only one patent was obtained in spite of there being 20 projects classified as technological sciences, but these technological projects, together with earth sciences have originated 60 reports and a big proportion of the monographs. The majority of the technological projects aim at solving local problems and many of them were immediately applied by the local industry, as expressed by some of the researchers.

Table 6
Output of the projects by document type

Countries	pap.	cong.	rep.	mon.	pat.	thes.	conf.	total
Argentina	65	73	15	7	–	4	17	181
Brazil	52	28	1	3	–	1	6	91
Chile	236	138	8	10	–	31	29	452
Colombia	4	4	–	–	–	1	–	9
Cuba	44	72	35	10	–	3	36	200
Mexico	34	28	1	3	1	6	58	131
Total	435	333	60	33	1	46	156	1064

Results per scientific field show that life sciences is the most productive field, mostly due to Chilean projects (Table 7). Another important field is technology (projects with Chile and Cuba), together with earth sciences, chemistry and agriculture.

Table 7
Output of the projects by scientific field

Field	Arg.	Bra.	Chi.	Col.	Cub.	Mex.	Total
Technology	16	8	86	9	76	27	222
Physics	10	5	34	–	18	8	75
Life Sci.	34	–	211	–	12	32	289
Earth & Space	77	11	1	–	14	50	153
Chemistry	28	21	30	–	38	–	117
Agriculture	1	–	90	–	4	–	95
Mathematics	15	3	–	–	–	5	23
Social Sci.	–	–	–	–	38	–	38
Astronomy	–	12	–	–	–	9	21
Medicine	–	31	–	–	–	–	31
Total	181	91	452	9	200	131	1064

When analysing the results per project, the mean number of results of all kinds obtained was little over 11; the most productive project was one of the life sciences field carried on with Chile with 148 results; it lasted the whole period of time studied and many scientists were implied.

Taking into account the time period and number of scientists involved, the productivity of the projects can be determined: a maximum of 2.2 results per year and scientist implied are obtained, while the mean is around 0.4.

Journals of publications

Nearly half of the results are scientific articles, the type of output easiest to detect through databases and to evaluate as to its scientific impact. A total of 435 articles have been published in 202 different scientific journals. In Table 8 a rank order listing of those journals where 4 or more articles were published is shown. As many different subjects are covered, a great dispersion in the titles is observed.

Table 8
Journals more frequently used and coverage by two databases

Journals	No. of articles	SCI	ICYT
Cell Biol. Int. Rep.	19	X	
An. Edafol. Agrobiol. (Spain)	13		X
Genetica	11	X	
Acta Biol. Leopold. (Brasil)	10		
Appl. Catal.	10	X	
Av. Prod. Anim. (Chile)	10		
Eur. J. Cell Biol.	10	X	
Rev. Agroquim. Tecnol. Aliment. (Spain)	8		X
Cytobios	7	X	
Exp. Cell Res.	7	X	
Monogr. Med. Vet. (Chile)	6		
Protoplasma	6	X	
Rev. Cient. Tec. Agric. Ser. Arroz (Cuba)	6		
Asclepio (Spain)	5		
Biol. Cell	5	X	
J. Cell Sci.	5	X	
Mutat. Res.	5	X	
Rev. Metal. (Spain)	5		X
Rev. Mex. Astron. Astrofis. (Mexico)	5	X	
Agrochimica	4	X	
Alimentos (Chile)	4		
Chromosoma	4	X	
Estud. Geol. (Spain)	4		X
Enome	4	X	
J. Catal.	4	X	
Rev. Campo	4		

Two main topics are present: life sciences, where the most productive projects are classified, published in mainstream journals; the second topic is agriculture and soil science, a very interesting topic for developing countries, published in Spanish language, mostly in Spanish or local journals, in accordance with their local interest.[9]

The diffusion of the journals in SCI and ICYT is analysed, as both these databases deal with science and technology fields. From all 202 journals used, 112 are covered by SCI and 20 by ICYT. Considering the total number of articles produced, this means that 55% of the articles are recorded by the SCI, 14% by ICYT and the rest, 31% is not recorded by any of the two. None of these journals are covered by both databases, as the SCI covers only very few Spanish journals, having a clear English language bias.

As for the country of publication of the journals used: 55% are "mainstream" international journals from USA and several European countries, while 23% are Spanish journals and 22% come from Latin-American countries. Only one of these Latin-American journals is covered by SCI. These results agree with those of the Philadelphia Workshop:[1] Third World Science is under-represented in international databases, in particular SCI, and only half of the output of developing countries of international level of excellence is included in this database.

Other non-quantifiable output results

Moreover, there are many other non quantifiable benefits that result from this scientific collaboration. According to the answers to the questionnaires they would be the following:

- cultural impact, with the advantage of having a common language, or a very related one in the case of Brazil;
- networking effects between scientists, relationships between partners have clearly changed before and after the project, casual contacts have changed into permanent collaboration and co-authoring; attendance to congresses has also contributed to this network;
- transfer of knowledge between groups involved and towards industry, complementary points of view;
- mobility of researchers;

- training of human resources has been a very important result, through working together in the joint projects, courses and dissertations; several projects were especially focussed towards the organization of international courses.

Among the shortcomings of these collaboration projects, the following were pointed out:

- the scarce economic aid has been the most usually mentioned; too short visits were sponsored and scientists had to use funds from other sources;
- bureaucratic problems;
- technical difficulties in communication with Latin-American partners, enhanced by the big geographical distance.

Final remarks

The creation and updating of this database on cooperative research projects can be useful in different ways. The scientific policy makers of the CSIC will be able to follow and evaluate these projects if, together with the present information on projects length, subject and type of the research, scientists and institutions involved, tangible and intangible results, also data on economic and material resources are introduced in the database.

Another interesting feature is the possibility of determining adequate fields for future cooperation with Latin-American countries. The scientific policies of these countries should be compared to that of Spain in order to determine in which fields we can collaborate and which are the topics of converging interests. This type of research on social sciences would help to bridge the "research gap" between Academy, public decision-making and industry, an important necessity especially in less developed countries, as highlighted by *Vessuri*,[10] and would give a better distribution of the always scarce human and economic resources devoted to research.

References

1. M.J. MORAVCSIK, Strengthening the Coverage of Third World Science, Philadelphia Workshop, 1985.
2. J.D. FRAME, M.P. CARPENTER, International research collaboration, *Social Studies of Science,* 9 (1979) 481-97.
3. A. SCHUBERT, T. BRAUN, International collaboration in the sciences 1981-1985, *Scientometrics*, 19 (1990) 3-10.

4. J.M. MIQUEL, Y. SHINOZAKI-OKUBO, N. NARVAEZ, L. FRIGOLETTO, Les scientifiques sont-ils ouverts à la coopération internationale? *La Recherche,* 20, No. 206 (1989) 116-118.
5. F. NARIN, E.S. WHITLOW, Measurement of Scientific Cooperation and Coauthorship in CEC-related Areas of Science. Commission of the European Communities, 1990.
6. H.F. MOED, R.E. DE BRUIN, A.J. NEDERHOF, R.J.W. TIJSSEN, International scientific cooperation and awareness within the European Community: problems and perspectives, In: *Indicators of Output Evaluation of EC Research Programmes*, 14-15 June 1990. Paris.
7. I. GOMEZ, A. MENDEZ, Are peripheral countries profiting from scientific cooperation networks? *Proceedings of the International Conference on Science and Technology Indicators*, Bielefeld, 10-12 June 1990.
8. UNESCO, International Standard Nomenclature for Fields of Science and Technology, UNESCO, Paris 1974.
9. M. ROCHE, Y. FREITES, Producción y flujo de información científica en un pais periférico americano (Venezuela), *Interciencia*, 7, No. 5 (1982) 279-290.
10. H. VESSURY, The social study of science in Latin-America (review), *Social Studies of Science*, (1987).