THE REPUBLIC OF COLOMBIA

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1. Considerations about the History of Science in Colombia

The articulation of a Science and Technology (S&T) System in Colombia began with the establishment of the National Science and Technology Council, formed as a consultative and advisory body for the government in 1968, and the Colombian Fund for the Development of Science and Technology (COLCIENCIAS - Spanish acronym) also in 1968 and which was responsible for the promotion and funding of S&T activities, principally in the area of research. From this year certain short-lived and uncoordinated attempts were made to develop S&T but without systematic support from the government.

Nevertheless, decades later, the development of critical masses in distinct production sectors and, above all, academics, led to the issuing of Law 29 in 1990 that led to the systematization of the S&T process.

We can briefly present the history of S&T in Colombia by the next list of events.

1.1 Phase, 1968 to 1989

- Creation of the National Council of Science and Technology
- Creation of several postgraduate programs
- Credits BID I – ICFES – Colciencias
- International Forum of S&T Policy (1987)
- Science & Technology Mission (1988)

1.2 Phase, 1990 a 1999

- Law 29 defining the National Policy in S&T
- Institutionalization of S&T System and the Regional Commissions of S&T
- Adscription to Colciencias in the DNP (Decret 585).
- Credits BID II – Colciencias (1990).
- Expedition of Law in 1992 giving Fiscal incentives for S&T activities.
- Science, Education and Development Mission (1993). •
- First CONPES of S&T (1994)
- Creation of the National Commission for Masters and PhDs.
- Credit BID III – Colciencias (1994-1998).
- National System of Innovation and Regional Systems (1995).
- Expedition of Law 344 in 1996- for the National Learning Service (Sena) Fund to Competitiveness and Technological Development Productive Programmes
- Creation of the Colombian Observatory for S&T (1999)[1.]

1.3 Phase, 2000 and beyond

- Conpes Document 3080 – Science and Technology Policy 2000-2002
- Creation of the Technological Prospective Programme (2001)
- Expedition Law 643 - Health Research Fund (2001).
- Definition of Regional Agendas for S&T.
- Creation of the Platform ScienTI (2002).
- National Ph D Programmes Support- BIRF Credit (2002-2003).
- Monetary Resources Incorporation in S&T issues- Law 344 in 1996 in the National Plan of Science and Technology Law in 2003.
- Calls to sponsor the Research Centres of Excellency (2004) in fields like Biodiversity and Genetic Resources; Prevalent Diseases in Tropical Areas; Modelling and Simulation in Phenomenon and Complex Processes; Culture, Institutions and Development Management; Advanced Materials and Nanotechnology; Biotechnology, Agro-alimentary and Agro-industry Innovation; Energetic Development, Information and Communications Technologies.
- Permanent participation of Colciencias in the Conpes (2004).

[1] Observatorio Colombiano de Ciencia y Tecnología, its aim is to create the S&T indicators to build a prospective vision http://www.ocyt.org.co/

- Presence of Ondas in all Departments of the country (2005).
- Science, Technology and Innovation National Programmes Reform towards Knowledge areas (2005): Basic Science, Health Science and Technology, Mining and Energy Researches, Agropecuary Science and Technology, Industrial Technology Development and Quality, Marine Science and Technology, Social and Human Sciences, Education Research Studies, Biotechnology, Environmental Sciences and Habitat, Electronics, Informatics and Telecommunications.

The principal institutions participating in the definition of policies in S&T are:

- The National Council for S&T, created in 1968 (Consejo Nacional en Ciencia y Tecnología)
- The Colombian Institute for the Development of S&T *Francisco José Caldas, also created in 1968* (Instituto Colombiano para el Desarrollo de la Ciencia y la Tecnología *Francisco José Caldas)*
- The Colombian Observatory of S&T, created in 1999

In the present time, we can find some other institutions composing the structure of S&T System in Colombia:

- 14 Public Institutions or Research Centres
- 19 Private Institutions or Research Centres
- 10 Public Institutions of Scientific Services
- 4 Public Institutions Services
- 35 Technology Development Centres
- 15 Public Universities
- 9 Private Universities[2]

[2] See http://www.campus-oei.org/guiaciencia/colombia.htm#0

2. The administration of Science in the country

COLCIENCIAS oversees National Programs and is assigned to the National Planning Department (DNP – Spanish acronym), which also provides its budget. For its part, The Colombian S&T Observatory is a private institution and receives funding support from Colciencias.

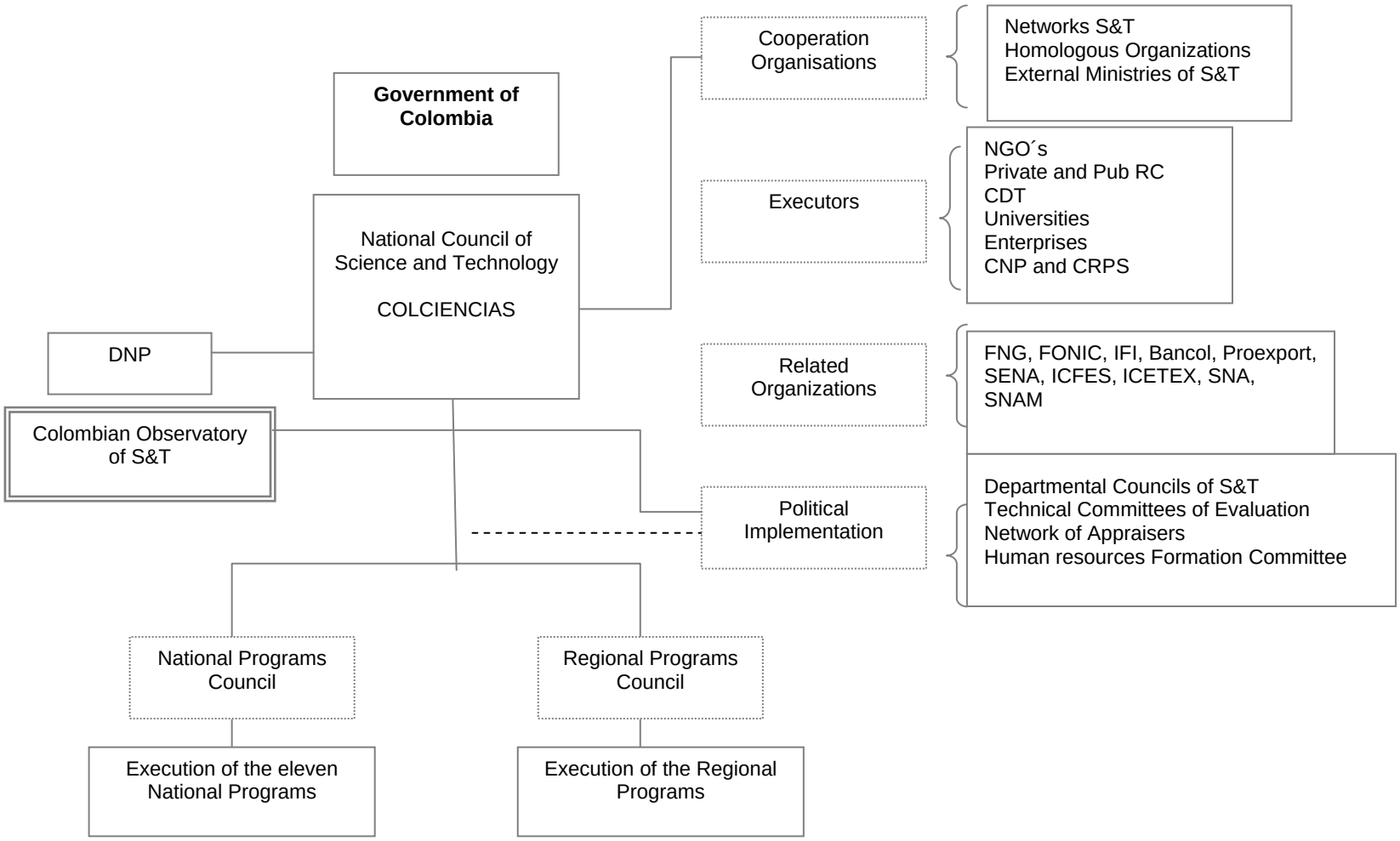
The Board of Directors of Colciencias is formed by:

1. The Director or sub-Director of the National Planning department, who presides.
2. The Minister or Deputy Minister of Economic Development.
3. The Minister or Deputy Minister of Agriculture.
4. The Education Minister or their delegate.
5. A representative from the National Science and Technology Council or their deputy, chosen from among the members.
6. The Director of Colciencias, who has voice but no vote.

In 1968 the National Science and Technology Council was formed as the governing body for science and technology policy and the "Francisco José de Caldas" Colombian Fund for Scientific Research and Special Projects (Colciencias – Spanish acronym) was founded as the governing body of the same and assigned to the National Education Ministry. Nevertheless, with the Law of 1990 there was a reorganization of their functions and the hierarchical position of both in their relationship with the system.

In this way the National Science and Technology System (SNCyT – Spanish acronym) was institutionalized and declared to have permanent character, and the National Science and Technology Council became the management and coordination body for the National Science and Technology System and the principal adviser to the National Government in such matters.

Diagram 1: Structure of the S&T System

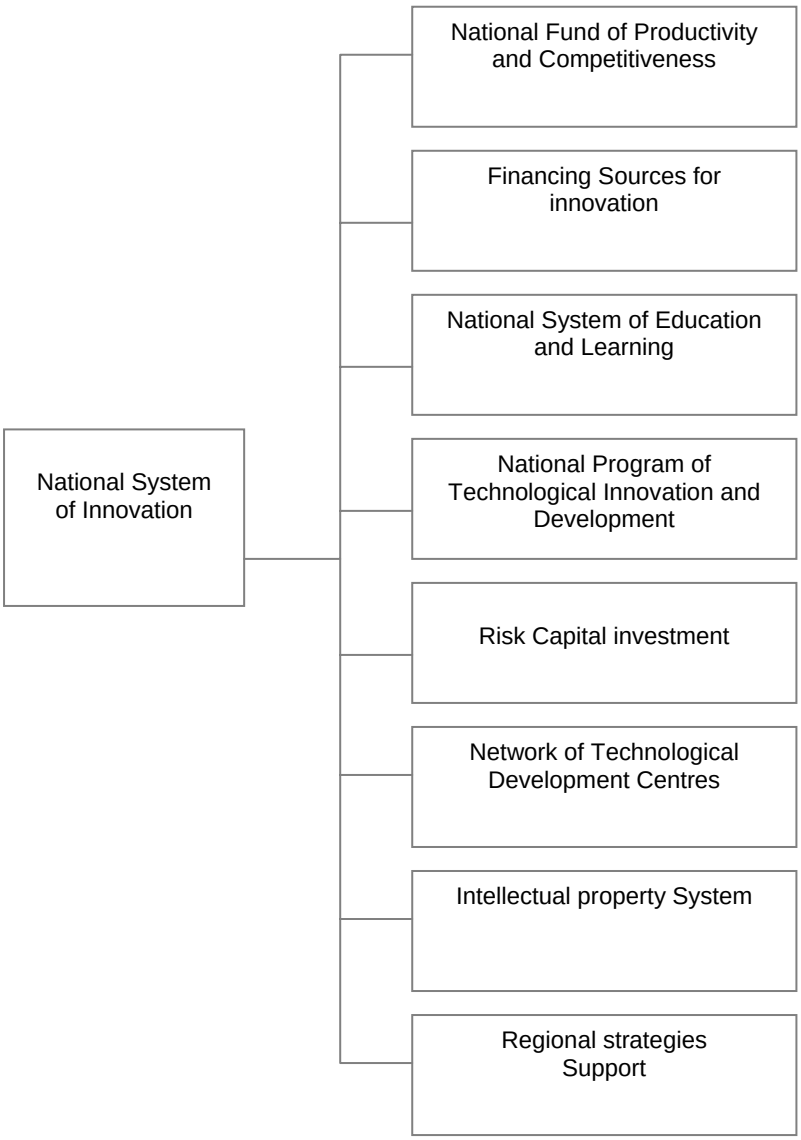


Among the most significant related bodies are the Colombian Institute for the Promotion of Higher Education (ICFES - Spanish acronym), and the National Learning System (SNA - Spanish acronym)[3].

The objective of the IFCES is to evaluate the Colombian education system at all levels and this makes it an important institution within the Colombian S&T system (although it is new and at present disorganized). (www.icfes.gov.co)

Based on a revision of document CONPES National Policy in Science and Technology 2000-2002, the following diagram has been prepared to demonstrate the articulation of economic and political actors with respect to a National Innovation System.

Diagram 2: Matching Elements in the Innovation System.



[3] For information concerning participation of the SNA in a possible system of innovation see diagram 2. The functions of the SNA are detailed in Table 2

2.1 Available policies

The Act defining national S&T policy was promulgated in 1990 and incorporated scientific and technological research into national development plans while creating the necessary conditions to stimulate innovation and technological management in national companies. It also promoted the National System of Scientific and Technological Information. Another action designed to favour the development of S&T was the Finance Ministry's creation of incentives for universities to import equipment with the prior authorization of Colciencias.

In addition, the National Council for Social and Economic Policy provided funds for R&D together with exemptions, tax discounts and other financial stimuli. The views of Colciencias were taken into account when contemplating these measures. Finally, the creation of spaces in the media for the reporting of S&T activities was made obligatory.

For its part, the National S&T Council assumes the role of director and coordinator of the National S&T system and Regional S&T Systems, and is the national government's principal consultant in matters of S&T. The "Francisco José de Caldas" Colombian Institute for Scientific and Technological, Colciencias defines the coordination mechanisms of the SNCyT, which is technical secretary, the national programs councils and regional commissions and councils.

The National S&T System is defined as an open system organized by S&T programs conducted in the form of projects and is determined by Development Plans in general and regional needs in particular.

With the issuing of Law 344 in 1996 the SENA became involved in funding for the development of competitiveness and productive technological development programs. The objective of the SENA is to promote and facilitate the generation and consolidation of new entrepreneurial initiatives demonstrating a high innovation and technological development content within the framework of the National Program for the Support and Strengthening of Incubators for Technologically Based Companies.

All of these details are taken from National Development Plan Law of 2003.

3. R&D Performers

As can be seen in the following table, very few private research centres exist, and in the information search, it was not possible to determine their contribution to the development of S&T. We may sense that their contribution is minimal as the table for R&D expenditure shows the participation of public bodies is very important and the participation of private centres represented just 12.68 % of the total in 2004.

Table 2: Institutions and their Aims

Institution	Scientific field	Status
COLCIENCIAS CCC		Public, with participation of diverse sectors: academic
Colombian observatory for S&T (Observatorio Colombiano de Ciencia y Tecnología, http://www.ocyt.org.co/	Creation of indicators, analysis and technological forecasting	Private
National Service of Learning (Servicio Nacional de Aprendizaje–SENA) http://www.presidencia.gov.co/sena	To offer and perform professional training for the Colombian population, enhancing their integral incorporation in productivity activities to support the social, economic and technological development in the country.	Public
Research Institutions or Centres		
Centre of Marine and Technological Researches of the Pacific	Sea Sciences.	Public
Centre of Oceanographic and hydrologic Researches (Centro de Investigaciones Oceanográficas e Hidrológicas (CIOH) http://www.cioh.org.co/	Knowledge of marine water, oceanographic and hydrologic, and integral management of the coastal area.	Public
National Institute of Fishing and Aquaculture (INPA) http://www.inpa.gov.co/	Fishing and Aquaculture	Public
Colombian Institute of Educational loan and technical studies Abroad (ICETEX) http://www.icetex.gov.co/	Financing for Human Resources	Public
Researches Institute in Geosciences and Mining (INGEOMINAS) http://www.ingeomin.gov.co/	Geology	Public
"Juan José Turbay" Colombian Petroleum Institute	Petroleum and derived (petrochemistry)	Public
Institute of Nuclear and Energy Sciences (INEA)	Energy	Public
Institute of Marine and Coastal Researches (INVEMAR) http://www.invemar.org.co	Ocean and coastal spaces	Public

Table 2 Continued

Institution	Scientific field	Status
Research Institutions or Centres		
National Institute of Health http://www.ins.gov.co	Technology transfer activities, its aim is to develop, to produce and distribute biological, chemical and biotechnical products; and issues of biomedical diagnostic.	Public
Agricultural Colombian Institute (ICA) http://www.ica.gov.co/	Technology transfer and the prevention of sanitary, biological and chemical risks for the animal species and vegetables.	Public
"Agustín Codazzi" Geographic Institute (Instituto Geográfico Agustín Codazzi, IGAC) http://www.igac.gov.co	Geodesy, tele-detection, geographical information, GPS systems, cartography	Public
Institutes of Scientific Services		
Colombian Institute for Development of Superior Education (ICFES) http://www.icfes.gov.co	Financing for formation of HR	Public
Researches Centre of Coffee (CENICAFE) http://www.cenicafe.org/	Agriculture (related to coffee industry)	Private
Colombian Corporation of Research (CORPOICA) http://www.corpoica.org.co/	Agricultural	Private
Corporation of Cattle and Agricultural Studies (CEGA) http://www.cega.org.co/	Agriculture and cattle raising	Private
Corporation for Socioeconomic Research (CINSET)		Private
Colombian Institute of Technical Norms (ICONTEC) http://www.icontec.org.co/	Normalization and metrology, in addition to enhance quality systems.	Private
Centre of Science and technology of Antioquia http://www.cta.org.co/	Efforts to link the three sectors by means of projects of R&D.	Mixed Corporation: government, private initiative, academy

Table 2 Continued

Institution	Scientific field	Status
Centres of technological development		
Corporation for Development of Biotechnology (BIOTEC) http://www.univalle.edu.co	Biotechnology.	Public
Institute of Training and Investigation of Plastic and Rubber (ICIPC) http://www.eafit.edu.co/icipc	Chemical and Plastic Industry.	Public
Centre of Training and Technological Development for Paper Industry (CENPAPEL) http://www.cenpapel.org.co/	Clean technologies, advisor in optimization of similar processes to the industry.	Private
Centre of Technological Research and development in food (CIAL)	Food.	
Centre of Innovation and Services for Footwear Industry (CEINNOVA) http://www.ceinnova.org.co	Technology transfer, design, quality management, technical support, development of products.	Mixed: Colciencias and associates capital
Textile Centre of Technological Research and development (CIDETEXCO) http://textil-confeccion.com	Textile: support in R&D activities for enterprises export-production.	Mixed: Colciencias and associates capital
Metalmechanic-Technological Net Centre (Centro Red Tecnológico Metalmecánica, CRTM)	Metal-mechanics	Unknown
Corporation for Industrial Development of the Biotechnology (CORPODIB) http://www.corpodib.com	Biotechnology: bio-combustible	Mixed: the most part of the Public
Centre Corporation of Technological Research and development of the Electric sector (CIDFT)	Electric	Unknown
National Centre of Technology of Agricultural Industry http://www.centia.org.co	Food	Unknown
Research Centre of Sugar Cane (CENICAÑA) http://www.cenicana.org/	Agronomy, technology transfer	Private without lucre
Centre Corporation of Research Aquaculture of Colombia (CENIACUA) http://www.ceniacua.org/	Aquaculture	Mixed
Research Centre Tropical Wine of Geneva (CENIUVA)	Agriculture, profitability of wine cultivations	Unknown

Table 2 Continued

Institution	Scientific field	Status
Centres of technological development		
Research Centre in Oil palm (CENIPALMA) http://www.cenipalma.org	Technology transfer related with the cultivation and their derivates	Private without lucre
Researches Centre of Telecommunications (CINTEL) http://www.cintel.org.co	Information Technologies	Private without lucre
Colombian Federation of Software http://www.fedecolsoft.org.co/	Information Technologies	Private without lucre
Universities		
National University of Colombia http://www.unal.edu.co/		Public
Industrial University Santader http://www.uis.edu.co/	Research Corporation of Corrosion (CIC) Corporation for Research and development in Asphalts for Transports and Industrial Sector (CORASFALTO)	Private
Pedagogic and Technological University of Colombia http://www.uptc.edu.co/direccion_investigaciones/index.html	Linking academy with the technological development of their respective areas.	Public
Cauca University http://www.ucauca.edu.co/	Several consult: http://investigacion.unicauca.edu.co/vri/index.php	Public
Antioquía University http://www.udea.edu.co/	Sciences several see: http://www.cta.org.co	Public
Valley University http://www.univalle.edu.co	biotechnology	Public
Cartagena University http://www.unicartagena.edu.co/cicte/web/index.htm	Centre of Scientific and Technological Research (CICTE)	Public
Amazonia University http://www.uniamazonia.edu.co/	Biology and engineering	Public
University of the Andes http://www.uniandes.edu.co	Several consult: http://investigacion.unicauca.edu.co/vri/index.php	Private
Medellín University http://www.udem.edu.co/	Engineering and Basic Science.	Private
Manizales University http://admin.umanizales.edu.co	Several see: http://admin.umanizales.edu.co/Investigacion/	Private

It is necessary to clarify a point with respect to the information given in the above paragraphs. The number of agents involved in the restructuring of science and technology indicated in section **I** varies with respect to the table included here as many centres are located in universities and some do not undertake R&D activities but are instead involved in administrative work.

4. S&T Human Resources

The following table offers data concerning the creation of human resources. As can be observed, the number of people with PhDs and Masters Degrees is limited if we compare this data with the 11 programs defined as priorities. Nevertheless, the table where we see the number of students with scholarships currently studying for Masters or PhD degrees can serve as an indicator of the efforts being undertaken to generate human resources. In effect, the figures demonstrate an important rise in the number of students with scholarships between 2003 and 2004.

Table 3: Number of Students with Scholarships in Masters & PhD programs in Colombia

Year	Number of students	PhD	Master
1995	185	142	43
1996	207	125	85
1997	312	168	144
1998	123	26	97
1999	119	31	88
2000	102	30	72
2001	126	32	94
2002	288	158	130
2003	231	106	125
2004	405	207	198

Source: OCyT 2005

Table 4: Total Researchers for sector (Master and PhD) -Colombia 2005-

Area	2005		
	Ph D	Master	College
Social Sciences	470	1116	857
Natural and Exact Sciences	657	600	678
Engineering and Technology	215	342	490
Medical Sciences	96	293	436
Agricultural Sciences	85	156	179
Non specified	128	215	342
Total	1523	2722	2982

Source: OCyT 2005

5. Sources of Research Funding

The S&T activities considered are those described in the OECD's Frascati Manual (2003) and these are experimental R&D activities; education and teaching activities in science and technology, as well as scientific and technical services. It has not been possible to establish with precision the amount spent on S&T by institutions and sectors in Colombia, but some general percentages, as shown in table 5.

Table 5: Percentage of the GDP of S&T Expenditure by Institutions (1998-2004)

Institution	1998	1999	2000	2001	2002	2003	2004
Public Institutions	37.37	36.15	54.27	47.72	37.09	44.92	45.03
Enterprises	8.78	2.59	1.72	3.47	6.25	8.42	5.77
Universities	36.82	41.48	33.36	30.87	33.69	35.11	36.52
Private Research Centres	17.02	19.78	10.64	17.95	22.97	11.55	12.68

Source: OCyT 2005

5.1 Patterns of R&D Expenditure

No information available

6. Research output

In relation to patents, we can see a clear difference between the applications submitted and the patents issued. An initial approximation allows us to say this difference is due to the backlog of paperwork for the issuing of patents; nevertheless, on calculating the efficiency index it was discovered that 40% of applications by residents and 43% of those by non-residents were led to the issuing of patents.

Table 6: Patent applications and patent granted in Colombia 1991-2004 (number)

Year	Application				Granted		
	Residents	Non-residents	PCT	Total	Residents	Non- residents	Total
1991	85	527	0	612	35	390	425
1992	120	575	0	695	35	213	248
1993	138	769	0	907	53	227	280
1994	124	867	0	991	95	595	690
1995	141	1093	0	1234	87	278	365
1996	87	1172	0	1259	44	326	370
1997	80	1497	0	1577	58	447	505
1998	161	1670	0	1831	59	417	476
1999	68	1615	0	1683	20	570	590
2000	75	1694	0	1769	21	574	595
2001	65	429	3	497	13	350	363
2002	52	198	331	581	12	360	372
2003	77	123	1009	1209	5	286	291
2004	85	116	1235	1436	11	284	295
Total	1358	12345	2578	16281	548	5317	5865

Note: PCT= Patent Cooperation Treaty.

Source: Inform OCyT 2005

6.1 Qualitative Assessment of the Research Profession

It was not possible to locate significant data concerning researchers in the country. The following tables contain data concerning researchers identified on the CvLAC database.

Table 7 Percentage of active Researchers associated by gender and scientific area

Area	Female	Male
Medical	50	50
Social and human	40	60
Natural and Exact	34	66
Agricultural	29	71
Engineering and technology	20	80

Source: Inform OCyT 2005

With respect to the data in the tables, we can see that in the area of medical science there is an equal distribution between women and men. However, a gap between them develops in each of the other areas identified and it is in favour of men while in the area of engineering the proportion of women to men is the lowest of all.

6.2 Scientific Mobility/Brain Drain

According to figures from the DNP, in 1999 alone Colombia lost 4.3 trillion pesos (some 2.28 billion dollars according to the exchange rate of December that year) as a result of the brain drain that, despite being constant in the second half of the 20th Century, became more acute in the 1990s as a result of the internal armed conflict.

It is also affirmed that there are 6,218 non-active R&D researchers in the United States of America, as compared to 4,377 active researchers involved in R&D activities in 1999[4]. Nevertheless, no further data or tables could be found that would permit systematic analysis.

7. Informal S&T Structures

While we were able to locate information concerning the existence of informal networks that link certain members of the Colombian Scientific community, it was not possible to obtain data concerning their activities. These networks are:

- The Colombian Association for the Advancement of Science (www.acac.org.co)
- The Caldas Network: a means of communication for the exchange of scientific and technological knowledge between Colombian researchers outside the country and those forming part of the national scientific community. This has the goal of linking together the country's science and technology activities.

8. Scientific Co-operation and Agreements

No information available

[4] Albornoz, M., E. Fernández y C. Alfaraz, Hacia una estimación de la fuga de cerebros, Documento de trabajo no. 1, Centro de Estudio Sobre Ciencia, Desarrollo y Educación Superior.

9. Conclusion

The S&T System has developed mechanisms to vitalize the system itself via the regionalization and decentralization of S&T policy. As can be seen in the organization chart, there are regional program councils that seek to revitalize the interaction of agents from a level of less aggregation. Nevertheless, this strategy would seem to have been established fairly recently and there are therefore no concrete results in the Colombian regions as can be seen in the report of Science and Technology Indicators in Colombia, 2005.

On the other hand, if national spending is compared to recommended levels of spending on science and technology indicated by the OECD and the OEI, according to which a country should invest at least 1% of GDP in science and technology activities in order to achieve sustainable development, it can be said that spending in Colombia is still very low and although it rose to reach its maximum level in the years 2001 and 2002, it has been in decline ever since and has now dropped to levels similar to those of 1998.

This drop in investment is almost understandable, at the most aggregated level, if we take into account the extremely low level of human resources production (Doctors) to which can be added the lack of a system that provides incentives for scientific research, but above all, articulation with the productive sector.

With respect to this last point, there are two lines of reflection. The first is that a vision of a National System of Innovation has found expression in leglisation and that, for reasons inherent to the concept; it dynamically links the S&T sector to the productive sector. Nevertheless, this vision is an *ex ante* approximation of the need to be and not *ex post* legislation of an incipient system of interaction for although economic agents already exist to form this, such as the SENA, clear and dynamic articulation that can be proven and analyzed to verify its functioning does not exist.

The information found reveals a negative tendency with respect to investment in S&T activities by the private sector. Neither did we find the existence of efficient mechanisms to produce incentives in the productive sector to innovate or increase S&T spending.

Another central aspect is the brain drain. While not all of these researchers were directly formed by Colombian institutions, highly qualified human resources prefer to take up residence overseas, where it would seem there are better opportunities to conduct research, than live in Colombia where political instability has affected the consolidation of policies for the development of scientific and technological activities and the articulation of a national S&T System.