

## Indicators of Science, Technology and Innovation in the Brazilian Biotechnology Sector

Currently, the biotechnologies, especially those based on molecular information and genomics, allied to the latest microelectronics developments, appear to be a key issue for economic development. They present decreasing costs; their offer seems to be unlimited even facing a growing demand; they allow to diversify the production structure creating new goods and services; they are pervasive and dynamic enough to transform rapidly a huge variety and diversity of productive activities; and thus, represent one of the fundamental basis of a new pattern of innovation, both technical and organizational, at worldwide scale<sup>1</sup>.

In this way, the biotechnologies involve challenges not only to the dynamism of developed world economies but also and mainly to developing countries, as Brazil, where there is an urgent need for appropriating existing technologies and accumulating endogenous capacity to the development of local agricultural and industrial productive structure.

However, in general, the proper identification of advancements on Science, Technology and Innovation faces methodologies barriers difficult to overcome. Generally, the conceptual framework for data systematization, which is supposed to be the basis to identification and to measure these advancements, seems to be not suitable for this purpose.

Some of the main database are organized by economic criteria (*International Standard Industrial Classification of All Economic Activities* - ISIC) or by knowledge areas such (biology, health, engineering, physics, chemistry, technology of information etc) which are not capable to deal with new biotechnology due its characteristics of pervasiveness, multidisciplinary and transversal approach across all this different economic and knowledge areas.

In this context, the paper aims to systemize some Indicators of Science, Technology and Innovation suitable to report the recent advancement of Brazilian Biotech sector<sup>2</sup>.

How could this be done? Due the existent controversies about this technologies field delimitation it is very important that a previous effort to properly define the meaning of biotechnology. Thus, for the purpose of this paper the main reference used is the Organization for Economic Co-operation and Development (OECD) definition: "*the application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or nonliving materials for the production of knowledge, goods and services.*"<sup>3</sup>

So, using this definition and its translation into key terms<sup>4</sup> and codes of International Patent Classification - IPC<sup>5</sup>, it was possible to access some databases

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<sup>1</sup> PÉREZ, Carlota. The new technologies: an integrated view. July, 1986. English version of the original Spanish; "Las Nuevas Tecnologías: Una Visión de Conjunto" (1986), in C. Ominami ed., *La Tercera Revolución Industrial: Impactos Internacionales del Actual Viraje Tecnológico*, Grupo Editor Latinoamericano, Buenos Aires, 1986, pp. 44-89 (<http://www.carlotaperez.org/papers/basic-anintegratedview.htm>).

<sup>2</sup> From 2000;

<sup>3</sup> OECD *Biotechnology Statistics* - 2006, p. 7;

<sup>4</sup> Biotechnology in Mercosul: english version of the original *Biotecnología en el Mercosur: Delimitación del Campo de Análisis* (2007) within the *Project Biotech - Inventario diagnóstico de las biotecnologías en el MERCOSUR y comparación con las de la UE*, p. 6 e 7.

<sup>5</sup> OECD *Biotechnology Statistics* - 2006, p. 44; e OECD *Compendium of patent statistics*, 2007, p. 18 ([www.oecd.org](http://www.oecd.org)).

currently available in Brazil and other countries to create indicators to Science, Technology and Innovation<sup>6</sup> as showed in the table bellow:

Table 1: Science, Technology and Innovation Indicators of Brazilian Biotechnology Sector.

INDICATOR	DATABASE <sup>7</sup>
1. Post graduation in biotechnology: quantity and areas of offered courses.	DataCapes ( <a href="http://www.capes.gov.br">www.capes.gov.br</a> )
2. Number of de researchers, PhDs and research groups in biotechnology	Plataforma <i>Lattes</i> ( <a href="http://www.lattes.cnpq.br">www.lattes.cnpq.br</a> )
3. Formal employment in biotechnology	Relação Anual de Informações Sociais ( <a href="http://www.mtb.gov.br">www.mtb.gov.br</a> )
4. Number of publications by Brazilian institutions cited in the Science Citation Index - SCI; Number of publications by Brazilian institutions with international cooperation in the SCI; Number of publications of Brazilian institutions with international cooperation cited in the SCI by country.	SCI ( <a href="http://www.thomsonreuters.com">www.thomsonreuters.com</a> ) e <i>Projecto Biotech – Inventario diagnóstico de las biotecnologías en el MERCOSUR y comparación con las de la UE</i> ( <a href="http://www.mincyt.gov.ar/web_biotech">www.mincyt.gov.ar/web_biotech</a> )
5. Number of patents on Biotechnology filed by citizens and foreign at Brazilian Agency for Industrial Property	INPI ( <a href="http://www.inpi.gov.br">www.inpi.gov.br</a> )
6. Number of patents on Biotechnology filed by Brazilian citizens at the <i>United States Trademark Patent Office - USPTO</i>	USPTO ( <a href="http://www.uspto.gov">www.uspto.gov</a> )
7. Number of releases to market of Genetically Modified Organism (GMO)	<i>National Committee for Biosafety Issues National Committee for Biosafety Issues – CTNBio</i> ( <a href="http://www.ctnbio.gov.br">www.ctnbio.gov.br</a> .)
8. Cultivation <i>area of GMO Crops</i>	<i>International Service for the Acquisition of Agri-biotech Applications ISAAA</i> ( <a href="http://www.isaaa.org">www.isaaa.org</a> )
9. Brazilian Biotech firms profile	Biominas Foundation ( <a href="http://www.biominas.org.br">www.biominas.org.br</a> )

Besides, OECD also set up a definition to biotech firms: “*the definition of a core biotechnology firm varies, but in most countries a core biotechnology firm must perform R&D in biotechnology and biotechnology must be its principal activity*”.<sup>8</sup>

Assuming this definition it is also possible to identify and to characterize the Brazilian biotech firms based on the survey done by BIOMINAS Foundation.<sup>9</sup>

<sup>6</sup> Others important references are available at: Frascati (OECD, 2002) and Oslo (OECD, 1997) Manuals ([www.oecd.org](http://www.oecd.org)).

<sup>7</sup> The methodology of these different sources of date will be discussed along with the paper.

<sup>8</sup> OECD *Biotechnology Statistics* – 2006, p. 8

A previous version of this paper was prepared by the authors. The main findings of this paper were:

- a) There is currently 31 post graduation programs in Biotech available in Brazil, most of them launched after 2000. Amongst them, 19 offer PhD and MSc degrees, 11 only MSc courses and 1 Professional Master Degree;
- b) Between 2000 and 2008 (April), the amount of Research Groups on Biotechnology rocket from 249 to 790;
- c) During the period 2003 – 2006, the number of biotech graduated employees presented a growing rate higher then 100% while biotech technicians presented a negative rate along the same period;
- d) Between 2000 and 2007, the Brazilian Publications cited in the *Science Citation Index* – SCI increased 300%. A third part of this publication is subject of international cooperation;
- e) During the period of 2000 and 2005, 512 patents were filed annually at Brazilian IP agency. In average, 93% of this patents were requested by non-residents;
- f) Regarding the *International Service for the Acquisition of Agri-biotech Applications* – ISAAA, amongst the four main producers countries (USA, Argentina, Brazil and Canada), Brazil presents the fastest rate of growth in the cultivated biotech crops area (30,4%) between 2006 - 2007;
- g) In Brazil, according to the *National Committee for Biosafety Issues* (CTNBio), only two biotech crops were allowed to be cultivated until 2006: *Roundup Ready* and *Bollgard I*. Within one year this agency has added three other biotech crops: *Libert Link*, *Guard* and *BT11*;
- h) According to the BIOMINAS Foundation, in 2007 there were 71 biotech firms in Brazil. The increase in the number of biotech firms in this country is recent: 51% were created after 2002 and 21% have between 5 and 10 years of operation. The biotech firms are clustered around Agriculture (22.5%), Imputs (21.1%), Animal Health (18.3%) and Human Health (16.9%). Roughly 78% of them are small business with less than 20 employees.

Summarizing, the paper aims to discuss possible ways to fill up the current lack of systematized indicators for biotechnology in Brazil, bringing up lessons that could be used for similar initiatives in other countries.

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<sup>9</sup> FUNDAÇÃO BIOMINAS. “Estudo das Empresas de Biotecnologia do Brasil” – 2007 ([www.biominas.org.br](http://www.biominas.org.br)).