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# The colors of biotechnology in Venezuela: A bibliometric analysis

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ABSTRACT

The background of biotechnology and its different specialty fields is assessed from a bibliometrics perspective, in a developing country within the Latin American region; Venezuela. As methodology we adopted a specialty coding by colors, a technique referred to as 'rainbow' proposed by DaSilva in 2004. The study was limited to publications from Venezuelan institutions in the period comprised within 1970 and 2010. The documentary information was retrieved from a database built for studies of this kind, referred to as Biblios. This database consolidates most bibliographic references related to Venezuelan publications spread among major international and domestic databases. Strengths shown by this database include, among others, the fact that each entry has been assigned the relevant code as set by the UNESCO nomenclature for fields of science and technology. By correlating the rainbow coding against the UNESCO coding we have been able to evidence that although biotechnology represents a third of national capacities in sciences and technology, current Venezuelan capacities only include 5 of the 15 colors in rainbow.


## 1. Introduction

Biotechnology penetration in multiple productive activities is generating a significant impact on new areas of exchange at scientific, technological, productive and social levels. Thus, influencing minimum knowledge thresholds, technical and productive facilities, intellectual property rights, activities developed in "downstream" production activities, and on the control of complementary assets, which generate new areas of exchange favoring creation for potential markets, making it feasible to yield additional

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profits [1]. So, building capacities and infrastructure for biotechnology is seen as a key factor for economic development in the 21st century, as it provides an opportunity for converting biodiversity into an economic and social factor through the appreciation, sustainable use, and preservation thereof.

Biotechnology is understood, in its broadest concept, as "technologies which support is provided by living beings". By such definition, human beings have been biotechnologists, as of the Neolithic Revolution times (about 10 thousand years ago) up to this date. By then, they started to domesticate plants and animals becoming farmers and cattle-breeders; selecting specimens showing those features deemed as more interesting; performing empiric hybridization practices, and learning about genetic improvement of species. Human beings did also discover and developed fermentations; with bacteria and yeasts …" [2]. In such sense, and for purposes of this study, the definition from the Organization for Economic Cooperation and Development (OECD) shall be used as the conceptual framework of reference. This definition describes biotechnology as the "application of science and technology to living organisms as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services" [3].

### 1.1. Biotechnology in the Latin American sphere

In Latin America, biotechnology had a vigorous start, by the 70's in the last century. In the late 80's, biotechnological materials and byproducts were used in pharmaceutical industries in Brazil (Biobras), Argentina (BioSidus), Cuba (human Interferon) and Chile (Bios) [4]. By 2014, from the 28 countries producing agricultural materials resulting from biotechnological designs, 11 were Latin American countries. Brazil stood out when ranked as the second country in the world, with 42.2 million hectares, while Argentina ranked as third with 24.3 million hectares [5]. In such sense, the highest density of biotechnology driving factors can be found in Brazil and Argentina, where public policies fostered in science, technology, and innovation fields are coherent and permanent over time, and focused on encouraging staff-training and skill-building, as well as on promoting innovation and technological transfer processes and bio-prospecting.

### 1.2. Biotechnology in Venezuela

In Venezuela, biotechnology started at the agricultural industry, by adapting plant tissue culture techniques, specifically by cloning cells from plant tissues and organs. This technique has a deep theoretical basis and had a significant impact on agricultural research by the early second half of the last century with its contribution to the improvement of harvesting plants. In Venezuela, the pioneering work on tissue culture was published in the Agro journal by researchers from the School of Agronomics of the Central University of Venezuela (UCV) in 1958, and addressed the embryo culture as phytotechnology aid [6]. Those researches were consolidated in the country as of the 70's, when Venezuelan professionals began to return from universities abroad, upon graduating from specialty courses in this field. As of that date and up to the present, approximately 90 centers have been created in universities and public entities [7].

Historically, the Venezuelan Government has mainly been the sole supporter for Science, Technology and Innovation activities (S + T + I) in the country. As for biotechnology, the government hires 78.4% professionals in this field and provides funding for 95% biotechnology programs and projects [6,8]. The Venezuelan biotechnological sector has gone through several stages, differing by funding issues, nature of the relevant research programs and projects, and the National Biotechnology Commissions created. Such commissions -formed in 1982, 1984, and 1996- were intended to advise the government in office on scientific and technological policies related to the biotechnology sector, particularly in the agriculture, industrial, biomedicine, oil and environmental fields. Even though never deemed as a national priority, the life of such commissions has always been quite short and with a secondary influence on public policies.

In 1982, the National Council for Scientific and Technological Research (Consejo Nacional de Investigaciones Científicas y Tecnológicas[2] - CONICIT) set an *Ad–Hoc* Commission for the "Study of Biotechnology and Alternatives for its Development in Venezuela". This group identified several initiatives for defining national programs related to biotechnology, which would be accompanied by the creation of the relevant advising commission. Here we must point out that one of the recommendations issued was to create a National Biotechnology System [8].

The National Commission for Genetic Engineering and Biotechnology (CNIGB) was created in 1984 [9], which deemed as important those remarks and suggestions made by the commission in 1982. By this time, priority areas for research and development were proposed, including: agriculture, biomedicine and industry; also considering creating a system intended to enable the confluence of universities and research institutes and industries based on biotechnological processes, in a harmonic and articulated manner.

In 1989 a global development strategy was initiated in Venezuela, based on the guidelines set by the *VII National Plan* as fundamental axis. A main goal for this plan was to develop competitiveness for the international sphere. This is how CONICIT concreted the design, organization and promotion for the New Technologies Program focused on activating, mobilizing, and modernizing the National Scientific and Technological Sector. Such Program would be carried out with funding from the Inter American Development Bank (IDB), which gave raise to the first Framing Agreement executed in 1992. Biotechnology was deemed one of the priority areas identified among cutting edge technologies. Other areas under consideration were informatics, electronics, fine chemistry and new materials. The program did also include fostering talent development and

[2] Former "Consejo Nacional de Investigaciones Científicas y Tecnológicas" (CONICIT) has been renamed and is currently known as "Fondo Nacional Ciencia, Tecnología e Investigación" (FONACIT).