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OPINION PAPER

Graduate programs in Brazil need reevaluation to contribute for innovation in biotechnology

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The regulatory context

Few years ago I attended BIO in Georgia, USA and verified that biotechnology in Brazil has the size of Georgia with a major difference, biotechnology in Georgia reaches industry and biotechnology in Brazil does not.

In Brazil one has to clearly distinguish between the advances of biotechnology in the area of agriculture and the advances in the area of pharmaceutical industry. Early in the 1960s, Brazil decided by law that the seed industry was going to be private. To back up this decision, under the Initiative of the Mississippi State University, some forty Brazilian professionals visited the seed industry in the US, to learn how the system operated. When designing the first law that later would regulate the commercial seed business in Brazil we had the support of Al Carter from the University of Iowa that instructed us that the Law should have one major article: what is in the label must be in the bag. Brazil created EMBRAPA in 1973 that established the first Foundation Seed Program. Together these decisions were later stimulated by biotechnology to the extent that Brazil produces today more than twenty million tons of grain and it is second only to the US with respect to the innovations in agriculture. The major agricultural biotech companies established themselves in Brazil: Monsanto, Dow and Dupont, Basf and Syngenta (acquired by Chem China). The regulatory framework exercised in Brazil, the patent and cultivar laws and the UPOV system satisfied the Ag biotechnology industry.

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In opposition to agriculture, the pharmaceutical industry decided to remain public, never accepting the patent law adopted in Brazil. The consequence is that the large companies operating worldwide never established in Brazil. Brazil does not innovate in biotechnology (De Castro, Neri, Bloch Junior, & Moraes Filho, 2013). But this is not the case of Countries like India, Mexico and Argentina where the pharmaceutical sector developed way beyond the Brazilian industry. We have not ever developed a ''block buster'' molecule in Brazil. We do not have one Good Practices Manufacturing Facility in Brazil and we do not compete with the Big Pharma that exports to Brazil to sell the most advanced products to the Ministry of Health. Every year we buy from foreign countries billions of dollars of drugs to satisfy our demands. Companies in Brazil that are nationally funded, import active principles, formulate and sell. They have not produced novel molecules, with a few exceptions.

In order to compete with the Big Pharma we have to change paradigms and take advantage of the revolution that happened in biology. To approach this issue we proposed biotechnology for the poor (Biotechnology, n.d.). Biotechnology must reach the small farmers. It is unquestionable that during the last four decades, the pharmaceutical industry has grown into a multi-billion-dollar sector. This occurred because the National Institutes of Health established very early rules to assure the safety of the work done with this nascent technology. This was consequence of the Asilomar Conference that took place in San Diego, 1975, and asked for a moratorium on the use of the technology, fearing that virus vectors might harm humans. While there have been a few lethal cases in the pharmaceutical area due to viral

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vectors, there have been none in agriculture, and no harm to the environment. As we mentioned previously, in Brazil the development of biotechnology, as we call it today, flourished in agribusiness. We are responsible for the cultivation of more than 40 million hectares of GM crops in Brazil, second in the world only to the United States. This is about 20% of the total grain production in Brazil and about 22% of the whole GM crop production in the world. Yet we cannot say the same with respect to the pharmaceutical sector, where large corporations do not invest in Brazil. We have never registered one molecule in the FDA, and we do not have a large-scale infra structure to work with gene expression in bacteria, yeast or Chinese hamster ovary (CHO) cells. Brazil simply does not innovate in the pharmaceutical sector. Change paradigms means expressing genes in plants and in the milk of animals, turning plants and animals into factories that would produce pharmaceutical molecules.

The financial context

The regulatory context prevents the development of biotechnology but this is not an isolated issue, it has to be

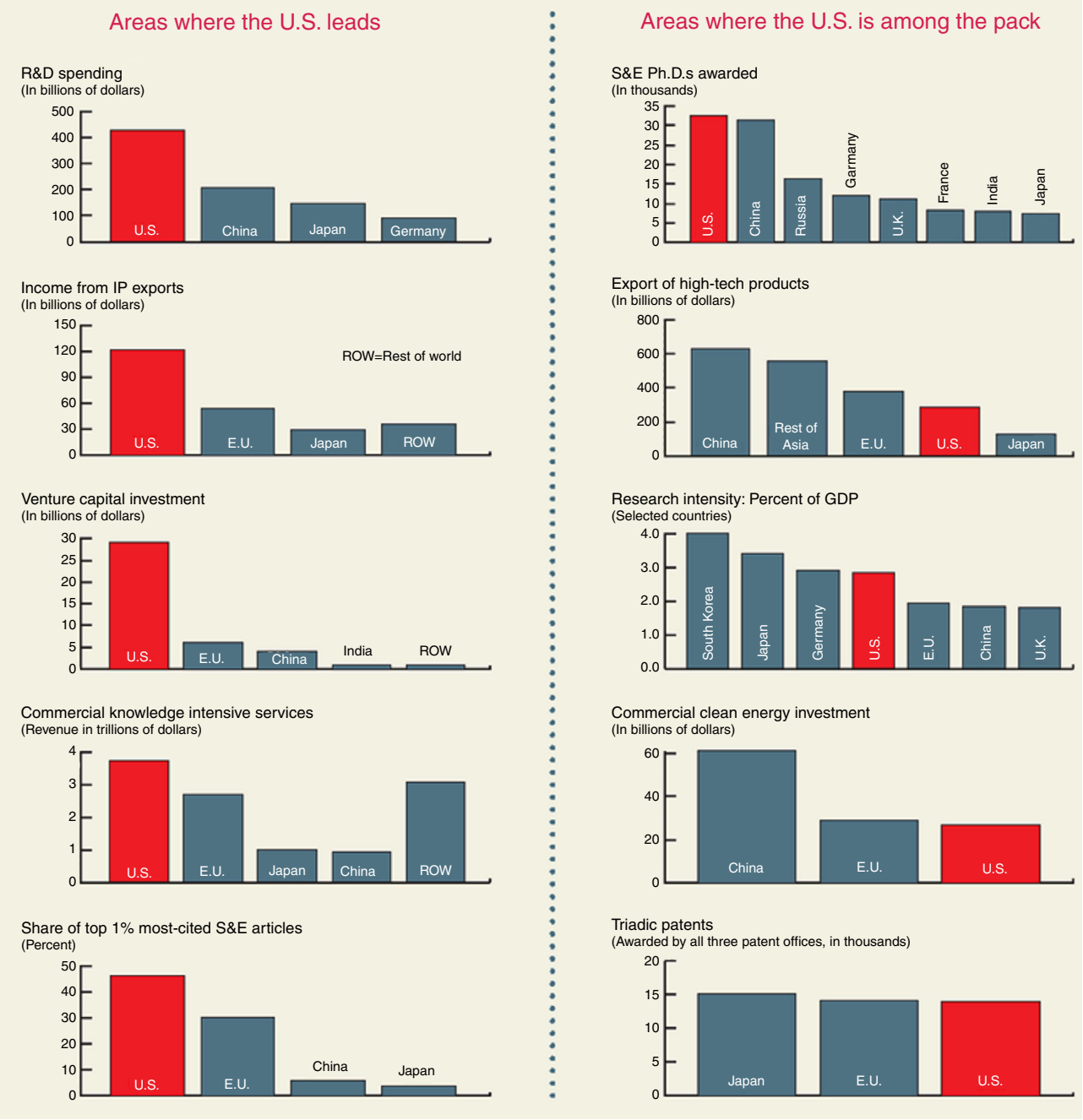

Figure 1 Where US leads and where it lags.

Source: Reprinted with permission from The American Association for the Advancement of Science (Mervis, 2014).

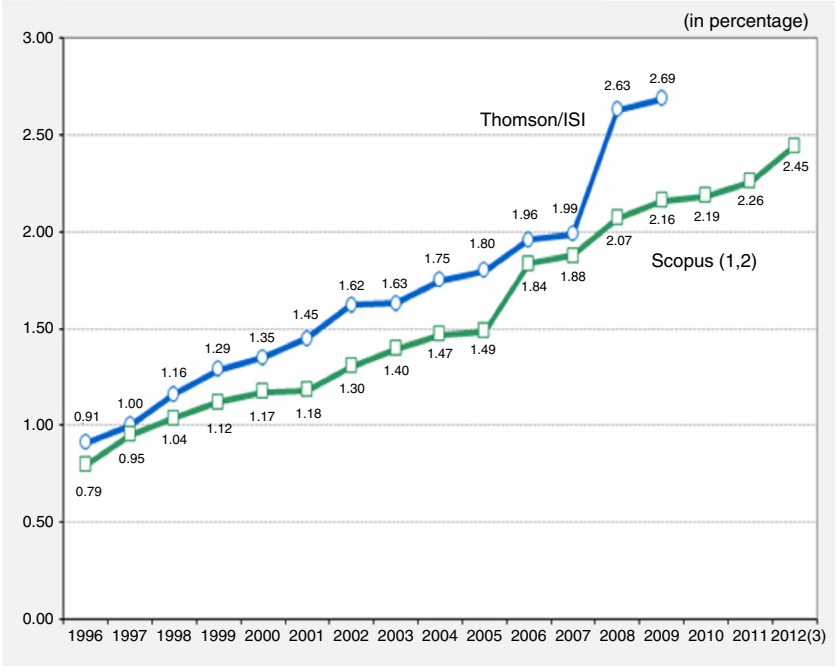

Figure 2 World scientific output in Brazil.

Source: www.mct.gov.br/indicadores.

seem as part of a larger picture. Brazil does not invest as it should in science and technology although the world output of science has grown considerably in the last decades (Fig. 2).

The world scientific output was even smaller during the sixties: Only 0.4%. So science was multiplied by six during the last six decades. Why these advances do not reach the industry? The reasons are financial. Brazil does not invest enough in science and technology. In comparison, US invests over 400 billion dollars in science and technology (Fig. 1). In contrast, the Brazilian investment in S&T in 2012 was only 25 billion US dollars (Fig. 3) (De Castro, 2010). The US

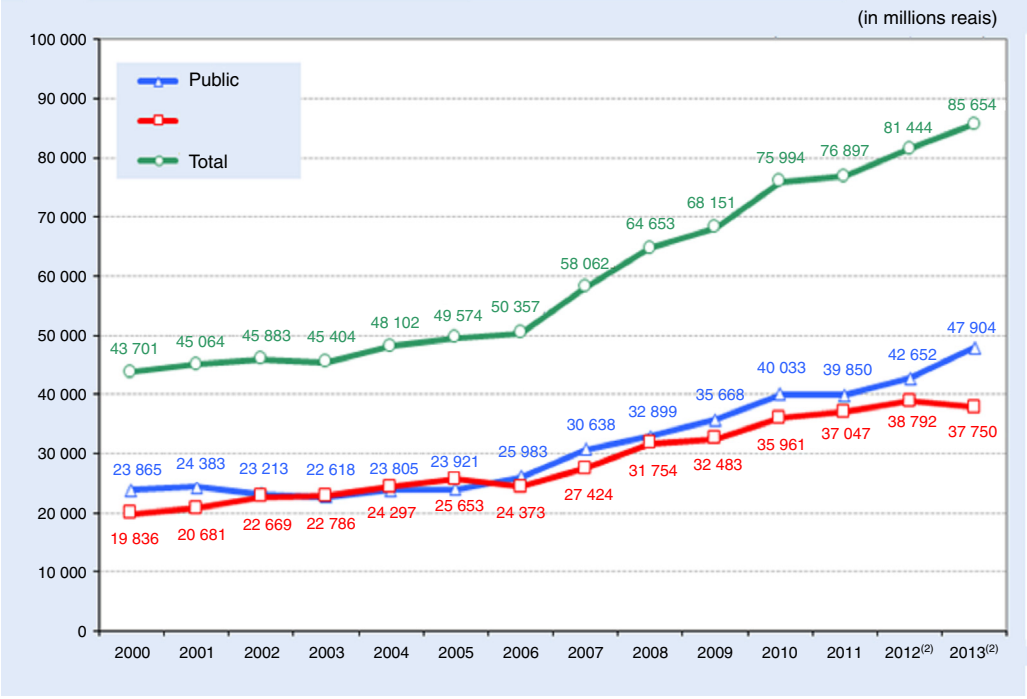

Figure 3 Brazilian investment in Sc&T: Public = publico, Private = Empresarial. 3.2 reais = 1 USD.

Source: www.mct.gov.br/indicadores.

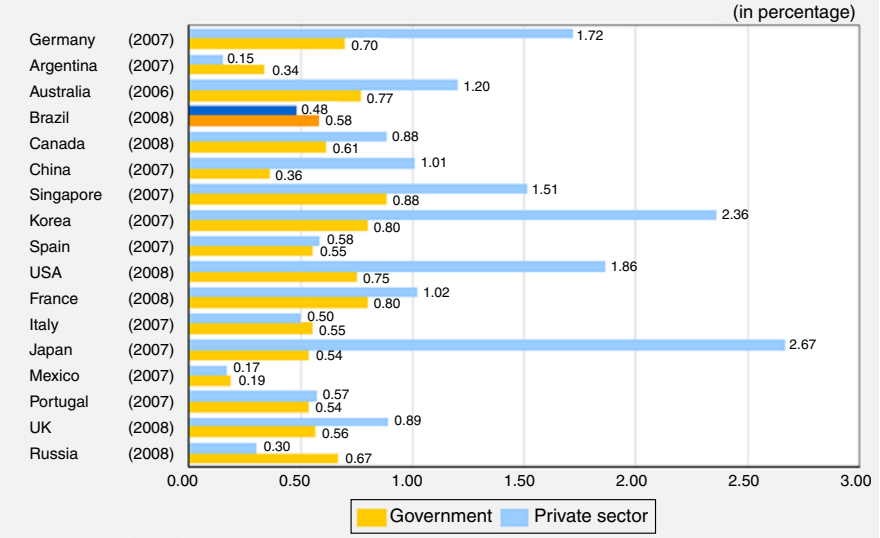

Figure 4 Investments in Sc&T from several Countries. Yellow: Government, Blue: Private Sector. Source: www.mct.gov.br/indicadores.

investment was 16 times larger than the Brazilian investment. The National Gross Income of the US is 8 times larger than the Brazilian National Gross Income. So our investment should be at least twice as much: 50 billion US dollars.

It is important to verify that the government of most countries including developed ones do not invest in Sc&T more than 1.0 of the National Gross Program. As we see in Fig. 4 France and Korea invest around 0.8 of their GNP. What indeed differentiate developed and developing countries is the investment provided by the private sector that in some countries like Korea and exceeds Japan 2.0% of the GNP. Although these are outdated numbers, we know that the Government of Brazil invests 1.0 of our GNP in Sc&T. However, we do not expect that in the future investment by the private sector would reach 2.0 of GNP, which, in addition to the public investment, would be more than many developed countries including England, Germany, USA and Singapore.

The second important financial problem is that biotechnology in the US reached the industry because the US applied close to 40 billion US dollars in venture capital (Fig. 1) while Brazil has little venture capital compared to the US. In addition, in the US the Government invests in a major Program called SBIR – small business innovation research. Later in this article, we will propose a program equivalent to SBIR. The only equivalent program in Brazil today is PIP, funded by FAPESP in São Paulo which is much smaller than SBIR. The SBIR has important goals (Fig. 5).

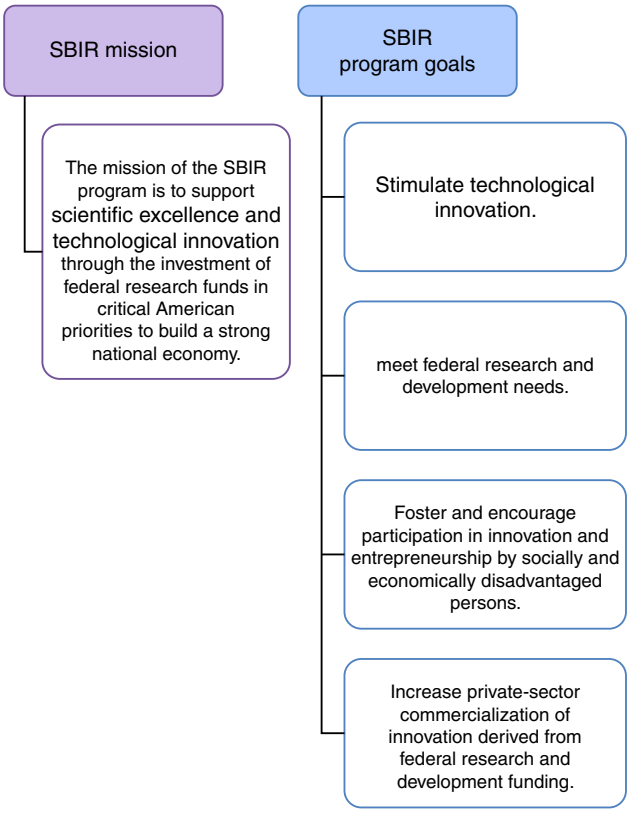

Figure 5 The goals of SBIR.

Graduate programs in Brazil – a review

There are 4.222 Graduate programs in Brazil, 1.458 PhDs, 2.503 MScs and 261 Professional MScs.

Numbers maybe out of data but the ratio between each program category is reliable. The conclusion is: we have a lot more MSc programs than PhDs; and the new category professional MSc is still of small relevance. Only 3% of these courses are biotechnology courses. The introduction of the last category (professional MSc) is recent and the expectation was that this course category was going to grow fast. It did not so far. The last commentary is that the system has few networks which are important for the following reasons: in the seventies doing a PhD in UC Davis I became acquainted with the Graduate Group System. The system allowed for students to include in their PhD programs disciplines offered by campi out of UC Davis. To be a member of a graduate group in

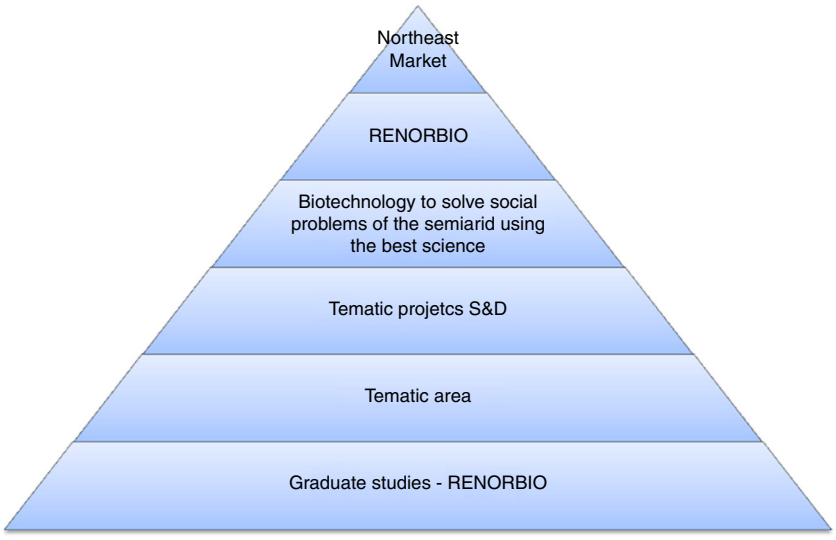

Figure 6 The RENORBIO diagram.

Source: www.renorbio.org.br.

Davisall that was necessary for a professor was to register as such and accept a number of students from the graduate group. In the seventies we did not have Internet. At the UC system all we had available was a private phone line within the UC system. Using the tie line one could call any professor in the campi of the University of California. Later in Brazil we decided to establish a network for biotechnology in Brazil. I called it RENORBIO in the North East of Brazil. Fifty institutions participated and disciplines of all of them were available for PhD students. RENORBIO had not MScs. Later using the same system I established BIONORTE and the Centro Oeste (De Castro, 2010). Together, geographically they cover 85% of Brazil. I then realized that thematic networks could also be created and we are in the process to create the first one in the area of health. Our expectation was that networks were going to take science to industry as we show in Fig. 6.

I will only translate the tip: MERCONORDESTE. We are not there yet. So I am proposing now another strategy based upon the fact that most master programs are not that relevant. I proposed to CAPES the agency that invests in graduate programs in Brazil to invest in professional MSc or PhD courses instead. The funds that we are going to generate we can use to establish a SBIR like program already described. The goal is to stimulate the development of small technological based companies. We think that the review of graduate programs in Brazil must include two goals: first, stimulate networks and generate professional MSc in substitution to regular MScs and second, funds must be available for a SBIR like program. The two goals may be interrelated. SBIR may fund companies generated by networks.

Conflicts of interest

The author declares no conflicts of interest.

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