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The Role of the South African Government in Developing the Biotechnology Industry – from Biotechnology Regional Innovation Centres to the Technology Innovation Agency

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Abstract: Biotechnology has been identified as one of the key sectors for future economic growth in many countries, with South Africa being no exception. Consequently, the South African government introduced the National Biotechnology Strategy (NBS) in 2001 whilst trying to modernize the government's biotech institutions and methods to develop the biotechnology industry given a changing political and technical environment. An important product of the NBS was the establishment of Biotechnology Regional Innovation Centres (BRICs) in 2002, which aimed to develop and commercialise the biotechnology industry. This was followed by the establishment of the Technology Innovation Agency (the TIA) in 2008. The latter institute's aims are to develop South Africa's ability in transferring a larger percentage of local research and development (R&D) into commercial products and services. This paper will explore and highlight recent changes in the role of the South African government in its attempts to support and develop the biotechnology industry firstly via BRICs and thereafter the TIA.

Key Words: Biotechnology, Biotechnology Regional Innovation Centres (BRICs), TIA, South Africa

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1. Introduction

Many countries have recognized the importance of biotechnology as a potential driver of economic growth in their economies (see, for instance; Poon and Liyanage, 2004). In addition, the

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biotechnology industry has been identified as having substantial potential to improve the quality of life and business efficiency in regions and nations (ITC, 2012). Given biotechnology's threefold potential for increasing economic growth, market dynamism and increasing levels of innovation, it comes as no surprise that this highly scientific industry is viewed as a key instrument to advance economic development by researchers and policy makers around the world (Tripl and Todtling, 2007).

Consequently, the South African Department of Science and Technology (DST) introduced the National Biotechnology Strategy (NBS) in 2001 whilst trying to modernize the government's biotech institutions and methods to develop the biotechnology industry given a changing political and technical environment. An important product of the NBS was the formation of Biotechnology Regional Innovation Centres (BRICs) in 2002, which aimed to develop and commercialise the biotechnology industry. The BRICs, however, were effectively replaced by the creation of the Technology Innovation Agency (TIA) in 2008, which also formed part of the DST's Ten-Year Plan. The latter institute's aims are to develop South Africa's biotech industry's ability in transferring a larger percentage of local research and development (R&D) into commercial products and services. This paper places the South African biotech industry in historical context, explores and highlights recent changes in the role of the South African government in the development of the biotechnology industry via BRICs and the TIA.

2. Defining the Role of Government in Innovation Systems

Few would disagree that an appropriate governance framework is important for sound public decision making with regard to scientific and technological development, as well as for promoting innovation. Indeed, this is recognised by the South African government as the TIA notes that its main mandate is "...to support and enable technology innovation...to achieve socio-economic benefits and enhance South Africa's global competitiveness." (Technology Innovation Agency, 2012: 8; also see Technology Innovation Agency, 2011). An innovation system governance structure can be defined as the institutions, structures and procedures government implements to promote innovation and the

provision of incentives to agents within the biotech industry, as well as the rules and structures that governs the interaction amongst the different role-players (Hartwich, Alexaki and Baptista, 2007). In other words, the governance framework for innovation systems reflect the institutions policymakers have developed that are supposed to foster and stimulate the creation and dissemination of knowledge and technologies in a country or region (Hartwich and Jansen, 2007). Importantly, such hierarchies and programs must consider stakeholder needs since any government intervention in the biotech industry is likely to fail if stakeholders are ignored.

Additionally, the level of centralisation of the governance framework for innovation systems also matter. In several countries the governance of innovation systems are more centralised, with high levels of departmentalisation and political administration sectoralization, as well as low levels of interaction, exchange and co-operation between various government departments and other government biotech institutions. However, evidence from developed countries reveals that a more decentralised approach might be more effective. Some researchers argue that a governance framework for innovation systems should rely less on centralised control and reporting systems and more on flexible, decentralized management practices as the latter framework is more likely to correctly incentivise biotech industry role-players. However, it should be noted that, no matter the level of centralisation/decentralisation, institutional leadership and political will is key for any governance framework to have a significant, positive impact (Hartwich, Alexaki and Baptista, 2007). Broadly speaking, the South African government's biotech institutions can be described as relatively decentralised, with an emphasis on regional rather than centralised, national structures as discussed below.

3. The South African Biotechnology Industry

3.1. The Background

The Republic of South Africa is the most southern country on the African continent. The Republic is bordered by five other countries, namely Botswana, Namibia, Mozambique, Swaziland and

Zimbabwe, whilst the Kingdom of Lesotho is an independent nation surrounded by South Africa.

Over the past two decades South Africa has faced radical political changes that changed the country from an isolated nation due to political sanctions and international trade and other embargoes as a result of the Apartheid regime to an emerging world economy post democratic elections that were held in 1994. During the Apartheid political regime, local scientific and technological capacities were encouraged and developed in politically strategic sectors such as the textile, mining and arms industries. The latter industries received greater attention from the government, but new, science-based industries such as biotechnology, biomedical, nanotechnology and others received less, if any, government support (Motari et al., 2004; Akermann and Kermani, 2006a; Cloete et al., 2006; Gastrow, 2008).

However, South Africa already had highly developed institutions in medicine. One frequently used example of South Africa's excellence in medicine is the first human heart transplant performed by Dr Christiaan Neethling Barnard at the Groote Schuur Hospital in Cape Town in 1967 (Akermann and Kermani, 2006a; Akermann and Kermani, 2006b; Al-Bader et al., 2009). Even considering that particular scientific feat, biotechnology received little direct support from the Apartheid government. The Apartheid government only started to show an interest in biotechnology during the late 1980s, but the field only gained considerable interest and government attention after 1994 (Gastrow, 2008).

In 2001, the DST launched the National Biotechnology Strategy (NBS) that was promoted as the key policy driver to build a biotech hub. Further, one of goals of the NBS was to promote the development of biotechnology knowledge, skills, capacities and tools in South Africa (Gastrow, 2008). Consequently, between 2004 and 2007, government allocated R450 million (approximately USA\$ 53.7 million³) in public funding for biotech development (Al-Bader et al., 2009; Louet, 2006).

The NBS also reached several strong conclusions from an international review of management of biotechnology activities, namely that:

- A dedicated agency was needed to champion biotech development in South Africa

³ Using the exchange rate of ZAR8.38 to the USA dollar as on the 28th of June 2012. If the start of year exchange rate of 2007 is used, the figure in USA dollars is \$64.3 million.

- Such an agency would be required to manage relevant activities to ensure coherence between programs
- Science & Technology capabilities must be built and strengthened, specifically targeting human resource development
- Investment in the biotech industry must focus on commercial biotech products and processes locally and internationally (Wolson, 2005).

In response to these findings, several economic and legislative initiatives were also planned to stimulate biotech start-ups and investment. For instance, the Ten Year Plan (2008 – 2018) developed by the DST regards the biotechnology sector as a priority sector and has initiated programs such as ‘Farmer to Pharma’ (see Gastrow, 2008 for more) to promote the biotech industry.

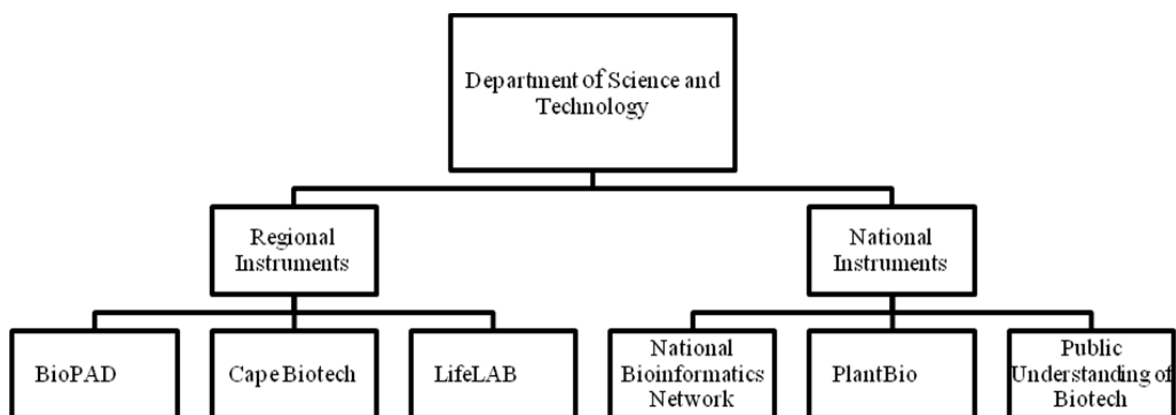
Another important step by the South African government was the attempt to encourage greater movement from research activities to commercialization by encouraging Public-Private Partnerships (PPPs) between local and international actors and by creating Biotechnology Regional Innovation Centres (BRICs) as discussed below (Cloete et al., 2006).

The government also enacted legislation entitled the “Intellectual Property Rights from Publicly Financed Research and Development Act, 2008” to allow researchers to better utilise intellectual property derived from publicly financed R & D. Another stated aim of this legislation is to create a National Intellectual Property Management Office, an Intellectual Property Fund and also to make provision for the creation of Technology Transfer Offices (TTOs) (Republic of South Africa, 2008a).

3.2. *The South African Biotechnology Institutions*

Initially, the South African National Biotechnology institutions under the leadership of the Department of Science and Technology could be sub-divided into two categories; namely regional instruments (discussed under section 3.2.1 and 3.3) and national instruments that include the National Bioinformatics Network (NBN), the National Innovation Centre for Plant Biotechnology (PlantBio), and the Public Understanding of Biotech institute (PUB) as shown in figure 1.

Figure 1: South African Government's Biotech Landscape prior to the establishment of the TIA



3.2.1. Regional Instruments (BRICs)

BRICs were created, together with two life sciences incubators called eGoliBio in Johannesburg and Acorn Technologies in Cape Town⁴ through the Godisa Trust in 2002⁵. The focal objective of the BRICs is to facilitate and support biotechnology innovation and commercialisation and some argue that these organisations represent the most important public tools to develop private biotech activity (Al-Bader et al., 2009).

Initially, there were three biotechnology innovation centres, specifically the Cape Biotech Initiative in the Western Cape, the East Coast Biotechnology Consortium (EcoBio, operating under the trade name of LIFElab) in Kwazulu Natal and the Biotechnology Partnership for Africa's Development (BioPAD) in Gauteng province (see Table 1). The BRIC institutions, now operating under the auspices of the TIA, have different areas of interest: Cape Biotech and LIFElab focuses on human health biotechnology research and development while BioPAD concentrates on several areas, including biotechnology research and development in the agriculture, mining, and environmental fields. The following sub-sections briefly discuss some of the past and current initiatives of the BRICs.

⁴ Acorn Technologies merged with Cape Biotech in 2009.

⁵ Now known as SEDA, the Small Enterprise Development Agency.

Table 1: Biotechnology Regional Innovation Centres (BRICs) in South Africa

| BRICs | Location | Aims |
|--------------|---|--|
| Cape Biotech | Black River Business Park, Cape Town | Industry development and capacity creation, distribution and managing government funds by investing in projects with potential in human health. |
| LIFELab | East coast region | The two primary program areas are human health and bio-processing. |
| BioPAD | The Innovation Hub Science Park, Pretoria | To promote industrial sector growth via process and product development; to improve mining competitiveness; to rehabilitate damaged environments or to prevent adverse environmental effects through the use of biotechnology. |

Source: Akermann and Kermani, 2006a

Cape Biotech Initiative

The Cape Biotech Initiative was incorporated as a Section-21 Company in 2002 (Pouris, 2008) with the vision to aid and invest in the development of a biotech economy by focusing on five selected areas, namely (i) nutraceuticals from biotechnology processes, (ii) drug delivery, (iii) point of care diagnostics, (iv) combination and conjugate vaccines, and (v) high throughput bio-prospecting (DST, 2006).

The East Coast Biotechnology Consortium (LIFELab)

LifeLab was incorporated as a Trust in 2002 (Pouris, 2008). LIFELab main aims are to promote economic growth in the biotech sector and to improve the quality of life in human health along the East Coast Region. Furthermore, LIFELab provides venture capital to projects that advances biotechnology growth in bioprocessing and research that aim to cure infectious diseases such as malaria, HIV/AIDS and TB (DST, 2006).

Biotechnology Partnership for Africa's Development

BioPAD was also created in 2002 as a National Innovation and Support Centre with funds from DST. For control purposes, these funds are administered by a Trust. The overriding goal of BioPAD was to develop biotech companies and stimulate economic growth by acquiring equity in the companies in exchange for financial assistance (Pouris, 2008). BioPAD's investments focuses on areas related to animal health, human health, as well as the industrial, mining and environmental biotechnology fields. Up until the end of 2006, the centre's investment in research projects had approached R200 million (around USA \$23.9 million) (www.biopad.org.za).

3.2.2. National Instruments

Prior to the establishment of the TIA, three national instruments were used to promote and develop the biotech industry.

National Bioinformatics Network (NBN)

The National Bioinformatics Network (NBN), located in Cape Town, was incorporated as a Trust. NBN was established to assist in the development of human resources, computing skills and facilities, networking, teaching, training and laboratory facilities within the bioinformatics field (Pouris, 2008). Unfortunately, NBN dissolved in 2008. It is unclear as to the exact reason for the closure, but it is potentially due to a lack of funding.

National Innovation Centre for Plant Biotechnology (Plantbio)

PlantBio was established in 2004 and was incorporated as a Trust (Pouris, 2008). PlantBio focuses on an array of areas such as food security and poverty alleviation, *in vitro* propagation, marker assisted and conventional breeding, biocontrol and biofertilisation, as well as plant transformation (DST,

2006). Plantbio has been absorbed as part of the TIA.

Public Understanding of Biotech (PUB)

Another initiative started in 2003 by the South African Agency for Science and Technology Advancement (SASTA) is the Public Understanding of Biotechnology (PUB) programme. SASTA, an arm of the National Research Foundation (NRF), was chosen by the DST (who funded the project) as implementing agency.

The reason for the establishment of the PUB was to endorse and proclaim the potential of biotechnology as contributor to economic development. In addition, the PUB is also seen as a possible forum for deliberation on current and potential future applications of biotechnology (Public understanding of Biotechnology, 2012). Interestingly, PUB is operating under the auspices of the DST and has not been absorbed by the TIA.

All of the above institutions were intended to play a vital role in stimulating and commercialising biotechnology by supplying finance, business infrastructure, and advice and above all by assisting biotechnology firms to grow and to eventually become settled, established firms.

3.3. Establishing the Technology Innovation Agency (The TIA) and its key contributions

The TIA Act was enacted in 2008 (Republic of South Africa, 2008b) and the creation of the TIA was planned to coincide with the DST's Ten-Year Plan (Tektiq, 2012). In the main, the TIA undertakes activities in industrial biotech, agriculture, health, technology innovation, engineering, advanced manufacturing technologies and information and communication technologies (www.tia.org.za) and is a single public agency that was formed from a merger of seven DST-funded organisations, namely, Tshumisano, Lifelab, BioPAD, Plantbio, Cape Biotech, the Innovation Fund and AMTS (Advanced Manufacturing Technology Strategy) (Msomi, 2009).

The TIA has two components, namely (a) the TIA central component and (b) the TIA regional component. The TIA central component's functions are to (i) develop national strategy, (ii) plan oversight & governance (including risk management), (iii) to provide regional support and coordinate all TIA functions, (iv) approve funding and also manages an executive investment portfolio.

On the other hand, the TIA regional component focuses on strategy execution and implementation in the various provinces. The latter component is also responsible for corporate strategy execution; developing regional partnerships and other linkages, developing technology nurseries, acting as the main client interface and to provide advisory services. Another important function of the TIA regional component is to identify and assess opportunities which are then referred to the TIA central component for funding. Lastly, the TIA regional component also manages funded projects (Msoni, 2009).

Together with private sector partners, the TIA aims to improve the country's ability to transform a larger percentage of local research and development (R&D) into successful, commercial products and services (Naidoo, 2009). In addition, the agency provides services such as (i) innovation financing, which incorporates several stages of funding over the life-cycle of a start-up biotech firm for development of commercially viable, technology-based goods and services; (ii) technology development, including technical and advisory services; (iii) promotion of domestic and foreign investment linkages; (iv) technological and enterprise expertise; and capacity-building, and (v) institutional and human capital development. The TIA's income for the 2010/11 financial year was more than R606 million (approximately USD \$72.3 million) (Technology Innovation Agency, 2011).

The key objectives and functions of the TIA are to:

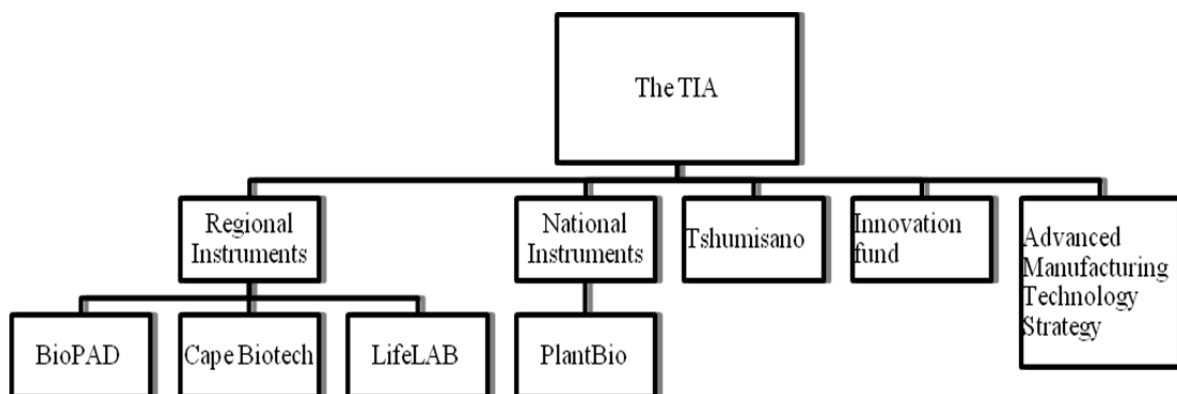
1. create a platform to connect the formal knowledge base (R & D) and the real economy (commercialisation of R & D into goods and services);
2. encourage the development of technology based products and services;
3. encourage the development of both public and private technology based enterprises;
4. grow a large technology base for the South African economy;
5. offer an Intellectual Property protection support platform;

6. encourage investment - including through facilitating venture capital, foreign direct investment (FDI) in R&D; and to develop human capital for the biotech industry and innovation fields (Naidoo, 2009).

The TIA considers itself as an organisation that is addressing “market failure” and aims to connect various role-players and to establish institutional linkages along the innovation value chain. Consequently, the TIA concentrates its financial and non-financial support in the gap between role-players, the so called “innovation chasm” (Msomi, 2009). The South African innovation chasm is composed of three distinct components that include: 1) A funding support gap for innovation and product development, 2) A cultural gap between developed countries and developing countries, 3) A capacity gap in human capital for innovation (Naidoo, 2009). Therefore, if the TIA is successful in bridging the South African Innovation chasm, the country could potentially see a substantial improvement in the development of the biotech industry.

One area of concern is that the new TIA structure appears to be more centralised, which, as discussed earlier, does not necessarily represent best practise as argued by Hartwich, Alexaki and Baptista (2007). However, a more in-depth study would be required to determine whether the TIA is, in actual fact, more centralized as compared to the structures in place prior to the TIA’s establishment.

Figure 2: The seven integrated institutions of TIA



3.4. The Current State of Biotechnology Sector in South Africa

Compare to developed countries, the biotechnology industry in South Africa is still relatively small and underdeveloped. According to the National Biotechnology Audit (DST, 2008), there are 78 active

biotechnology companies of which 38 companies are core biotechnology companies. A “core” biotechnology company’s major economic activity is within the biotech field and uses a minimum of one biotechnology related technique, whereas an “active” company either manufactures and sells biotechnology products or performs R&D in the biotechnology field. Active firms employ more people than core firms with the total number of employees in the former reaching more than 72,800 as compared to the latter that employ 765 people. The revenues of active firms reached R767.6 million (approximately USA\$ 91.7 million) during 2006 (R624.4 million (approximately USA\$ 74.5 million) during 2004). In contrast, the turnover for core firms was R520 million in 2006 (see table 2).

Table 2: Core and Biotechnology Active Companies in South Africa

| Characteristics | Core Biotechnology Companies | Active Biotechnology Companies |
|-------------------------|--|---|
| Number of companies | 38 | 78 |
| Location | Gauteng 43%, Western Cape 30%, KwaZulu-Natal 19%, Rest of SA 8% | Gauteng 43% Western Cape 26%, KwaZulu-Natal 12%, Rest of SA 19% |
| Spin-offs | Companies 16 (From universities 44% From government 31%) | Companies 25 (From universities 28% From government 36%) |
| Foreign Owned | Companies 5 | Companies 12 |
| No of employees (2006) | 765 | 72844 |
| Products | 559 | 1542 |
| Profits (2006) | R 520 million | R 767.6 million |
| R&D expenditure | R 76 million | - |
| Fund raised (2003-2006) | R216 million | - |
| Major funding sources | BRICs 36% IF 19% | - |

Source: DST, 2008

Note: BRICs: Biotechnology Regional Innovation Centres, IF: Innovation Fund

4. Discussion and Concluding Remarks

Countries around the world have developed programs and incentives in order to foster the development of biotechnology as the latter industry has been identified as a potential driver of economic growth. As a result, an argument for Governments to get involved in the biotech industry by developing strategic plans, promoting and developing the biotechnology industry has grown stronger over time. In particular, governments can assist the development of the biotech industry by directly investing in and providing investment incentives for technical, physical and knowledge infrastructure, foster collaborations between various stakeholders and to strengthen innovative capacities.

There is little doubt that the South African national system of innovation has developed a substantial repository of local and international knowledge. Unfortunately, this knowledge has mainly been seen in academia and has not translated into viable products and services due to several institutional constraints. These impediments, as discussed by Naidoo (2009) include, amongst others, a lack of access to adequate financing (and particularly seed and first-stage financing); market inefficiencies; a relatively weak and uncoordinated Intellectual Property (IP) rights framework; as well as a lack of institutional coordination and alignment within the national system of innovation.

As a result of the above-mentioned constraints, government decided to integrate interim support institutions such as Biopad and Plantbio into the TIA in an attempt to solve these issues. The government has also made a sizeable financial investment in the TIA; however, it is not clear at this stage whether such an investment will be sufficient to allow South Africa to compete with other emerging markets in the biotech field. However, few can argue that the South African government, within a historical context; is currently doing more now to promote the development of the South African biotech industry than ever before.

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