

Biotechnology Capacity: Comparative Case Studies

Presented to NATIONAL ADVISORY COUNCIL ON INNOVATION

National Biotechnology Advisory Committee

Department of Science and Technology,

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Executive Summary

Background

The South African Government has identified biotechnology as a key technology platform and is in the process of implementing a policy framework to promote the development of a national biotechnology industry. The policy interventions have been designed to bridge the "innovation chasm" between research institutions and industry, which exists as a consequence of inadequate support and weak linkages between stakeholders.

Purpose of the study

In previous years, South Africa has undertaken audits to assess the biotechnology sector. These studies have provided baseline information on the status of the biotechnology sector and the constraints that it faces. In contrast to these studies, the primary purpose of the current study is to compare the South African biotechnology sector with a number of selected groups of international countries who are considered to be successful in terms of capacity of their biotechnology sectors. Through this benchmark study, South Africa can learn from these experiences and identify actions that can be implemented to develop a competitive biotechnology sector.

Approach

To undertake the study, we will combine qualitative and quantitative methods in order to provide in-depth overviews of national policy instruments that foster biotechnological growth and performance in science and commercialization of biotechnology. The study will be conducted in four phases.

Phase 1: Current Status of Global Biotechnology

In this phase an overview of global biotechnology will be presented. The overview will take a reflective look at events that are shaping the industry. This overview will cover recent development in this sector such as market changes and convergence, competition, regulatory issues, and technological advancements and IP

issues. Information sources for this section will be published reports some of which are mentioned under the Project Design and Methodology section.

Phase 2: Development of Biotechnology Profiles of selected Countries

From the brief, it is clear that from the list of topics to be included for each of the country case studies that a combination of statistical and narrative information needs to be collected and analysed. The elements that will be covered in this phase are detailed in the Project Design and Methodology section.

Phase 3: Comparisons of Biotechnology Sectors of Selected Countries

To compare the biotechnology innovation systems of South Africa with selected countries, we will rely on the country profiles and comparative studies such those that have been published by OECD, Europa, European Union Biotechnology Innovation scorecard and Biopolis. Although these studies have methodological limitations, they are the most comprehensive reports that cover the key innovation indicators in biotechnology.

Phase 4: Gap analysis and recommendations

In this phase, a gap analysis will be carried out to identify the most significant areas of improvement in the South African biotechnology sector by using an improvement matrix. The list will be prioritized and possible solutions will be evaluated. Recommendations to policy makers will be made on the basis of the findings.

Deliverable

The final report will be structured in four parts. Section A will provide background to the study, its objectives and the approach that was used to achieve its objectives. In this section, an overview of the status of global biotechnology will be presented. Section B will cover the biotechnology country profiles. In section C, the comparison of the selected countries will be presented. Section D will cover the main findings, areas of improvements for South Africa and recommendations. Sources of information will be appended and other relevant references will be appended.

Benefits of Our Approach and Team

From previous assignments, members of our project team have acquired extensive experience and knowledge of international biotechnology. High Impact Innovation was appointed to develop profiles of National Innovation Systems of more than 40 countries and we became familiar with developments in Biotechnology in these countries. In addition some of the team members have practical knowledge of biotechnology having worked in research institutions and in industry.

In selecting comparator countries, we have included developed, small sized and developing countries. We have taken into consideration the diversity of approaches which governments are taking to develop their biotechnology sectors. This provides an opportunity to compare South Africa with a broad spectrum of countries whose state of development of their biotechnology sectors differs. Some of these countries were also included as case studies in the National Biotechnology Strategy document.

BIOTECHNOLOGY CAPACITY: COMPARATIVE CASE STUDIES

1 BACKGROUND

Modern biotechnology is one of the key enabling technologies of today. Governments have recognised since long that biotechnology industry can make a considerable contribution to the national economy, not at least through its multiplier effect. It has become the driving force for dramatic changes in innovation processes in many sectors. However, the development and implementation of biotechnology is rather diverse across countries and also within countries. Although part of the explanation might come from historic, geographic, economic or demographic factors, government policy measures are an important key for understanding why biotechnology shows such large differences in growth patterns between countries. Furthermore, one of the key insights that has emerged is that the biotechnology sector has a different business model.

1.1 Overview of Global Biotechnology¹

The biotechnology sector has grown dramatically and in 2005, global revenues for publicly traded companies grew by 18% on the previous year to \$63.2 billion (R407 billion) with the United States accounting for 75% of the total. This growth was generated on an increase of just 4% of research and development costs and a mere 1% growth in the number of publicly traded companies to 671. In all, net losses for the global industry fell 30% to -\$4.4 billion (-R28 billion). During this period the Asia-Pacific also became the first region to turn profit.

Some of the most recent developments have been the increase in the number of novel compounds approved by the Federal and Drug Administration for the biotechnology industry. Of importance is that this has been achieved on the third of the R&D spent. The potential for biotechnology to bridge the existing innovation gap is leading to a growing convergence of the pharmaceutical and biotechnology sectors.

¹ Ernst & Young, The South African Biotech Review 2006

The developing world is also playing an important role in the development of the global sector. Since the introduction of the first commercial genetically modified crops in 1995, over a billion acres have been planted, 40% is planted in the developing countries.

During the same period, competition from therapeutically equivalent biologics or biogenerics has been increasing as the first industry drugs come off patent. The industry is seeking strategies to reduce the cost of bringing new drugs to trial. These include the failure rate by identifying patient subpopulations that most benefit from new products, co-relocating research and development activities and developing improved understanding of regulatory issues.

Government and academic endeavours in basic research are a critical element of the industry success. The need for funding of basic research an innovation remains crucial.

1.2 Biotechnology Policies and Initiatives in South Africa

The South African Government has identified biotechnology as a key technology platform and is in the process of implementing a policy framework to promote the development of a national biotechnology industry. The policy interventions have been designed to bridge the "innovation chasm" between research institutions and industry, which exists as a consequence of inadequate support and weak linkages between stakeholders. In South Africa, the foresight studies that were commissioned by the then Department of Arts, Culture, Science and Technology (DACST) in 1998 highlighted the importance of biotechnology in future economic growth and social development. In response to the foresight study, the Department of Science and Technology developed a Biotechnology Strategy that was published in 2001². The National Biotechnology Strategy [NBS] was published in 2001, and was largely informed from the White Paper on Science and Technology and the constructs of the National Research and Development Strategy issued in 2002. The NBS has framed the way forward for the development of the biotechnology industry in South Africa. The document although named a strategy document, is to a large extent a policy document as few

² National Biotechnology Strategy 2001

measurable objectives appear to be present. The document, nevertheless creates the operating framework within which specific strategies can be formulated.

This strategy states that South Africa has a solid history of engagement with traditional biotechnology. It has produced one of the largest brewing companies in the world; it makes wines that compare with the best; it has created many new animal breeds and plant varieties, some of which are used commercially all over the world and has competitive industries in the manufacture of dairy products such as cheese, yoghurt and maas and baker's yeast and other fermentation products”

However, South Africa has failed to extract value from the more recent advances in biotechnology, especially over the last 25 years with the emergence of genetic engineering (3rd generation biotechnology). To address this challenge; the strategy outlined government policies to develop a sustainable and responsible industry and detailed strategic interventions to benefit from the potential of Biotechnology. The strategy promotes development and utilisation of biotechnology at three levels

- Basic research and technology development
- The development of ideas into products
- The commercialization and marketing of the products nationally and internationally

To facilitate the implementation of the strategy, a number of structures and interventions have been initiated. The most prominent are the Biotechnology Regional Innovation Centres (BRICs) which will support and develop human health, animal health, and industrial biotechnology portfolios. On the other hand, the National Plantbio Innovation Centre will focus on competitiveness and food security issues in plant biotechnology. In addition to these centres, the National Bioinformatics Network was created to develop capacity and expertise in bioinformatics. The last important intervention is the Public Understanding of Biotechnology Programme, which is intended to ensure an understanding of the scientific principles. Biotechnology is the subject of public debate and some of the areas have resulted in vigorous public debate. This programme will shape public attitudes on these issues and highlight the benefits of the technology.

1.3 Biotechnology Audit 2003

A number of biotechnology audits have been undertaken over the last decades, which were used to determine the level of activity of biotechnology in the country³. The most recent in 2003, a National Biotechnology Audit⁴ was commissioned by DST in partnership with EgoliBio, the biotechnology incubator in Gauteng. The aim of the survey, among others, was to establish a comprehensive database of all the biotechnology companies in South Africa as well as research that is being conducted. This provided a baseline that can be updated regularly to give an idea of growth and development within this sector. The report, published towards the end 2003, revealed that the South African biotechnology industry is relatively small and is still at its infancy. Out of 106 companies that were identified, 47 were core biotechnology and 59 non-core biotechnology. Of the core biotechnology companies, 39% were in human health, followed by the support services sector (13%). The study showed an uneven distribution across plant, animal health, food and beverage, industrial and environmental sectors and a small proportion of the companies contributing to the “other” category. The majority (26%) of the non-core biotechnology companies are in the plant sector with 15% engaged in human health sector and another 15% in the industrial sector. Most of the non-core companies are based in Gauteng, North West, Limpopo and the Mpumalanga area.

2 RATIONALE AND BRIEF

In previous years, South Africa has undertaken audits to assess the biotechnology sector. These studies have revealed baseline information on the status of the biotechnology sector and the constraints that it faces. The primary purpose of the current study is to undertake a comparative study of South Africa relative to a number of selected international countries that are considered to be successful in terms of the capacity of their biotechnology sectors. Through this benchmark study, South Africa can learn from these experiences and identify actions that can be implemented to develop a competitive biotechnology sector.

³ FRD, 2003; Innovation Biotechnology 1995; ProBio 2000

⁴ National Biotechnology Audit, 2003

2.1 Specific objectives and Scope

The specific objectives of the study are to compare the biotechnology capacity of South Africa with selected countries. The specific objectives are:

- To identify and select comparator countries based on both their current biotechnology performance as well as their growth over time.
- To determine the size and contribution of the biotechnology sectors to national economies with regard to both economic and employment growth.
- To develop profiles of the selected national biotechnology sectors (and sub-sectors) the following elements :
 - The relative sizes of the biotechnology sectors in relation to the general economy as well as other key sectors.
 - The nature and 'level of generation' of key products and services and their related markets.
 - The focus of state and private biotechnology-related investment and the reasons for supporting such directives.
 - The resources dedicated to biotechnology R&D activities including funding and employee hours (FTE) .
 - Available information on biotechnology human resource bases (workforce).
- To determine the dominant means and experiences of biotechnology sector participants in accessing and/or developing relevant capacity including:
 - The knowledge and intellectual property (IP) upon which innovations are based.
 - Human resources at appropriate levels and specialisations, and in sufficient numbers.
 - Financial capacity, particularly in support of new ventures.
 - Industrialisation capacity, access to relevant product development and manufacturing partners.

- Other necessary capacity such as temporary facilities
- To identify barriers that are encountered by the biotechnology sector participants in realising potential growth (e.g. the legal framework, ethical issues, finance, coordination, access to markets etc)
- To identify the presence of any un-utilized or under-utilized biotechnology-related capacity, the reasons for this and suggestions for improved utilization
- Based on the findings, to make strategic recommendations for improving South Africa's biotechnology capacity taking into consideration the practical aspects in terms of context, costs of implementation and the current situation of the Biotechnology industry in South Africa.

Definition of Biotechnology and its scope

The OECD has developed both a single definition of biotechnology and the different types of biotechnology.

The single definition defines biotechnology as *"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. 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."*⁵

The scope of biotechnology covers the following sub-sectors

- Human Health
- Industrial Bio-processing
- Animal Health
- Mining and Environmental Biotechnology
- Bioinformatics
- Plant Biotechnology

⁵ OECD Biotechnology Statistics - 2006

3 Project Design and Methodology

The ever increasing and pervasive role of biotechnology in national and regional development and economic competitiveness has led to a number of methodological approaches in assessing and comparing the strengths and weaknesses across different sectors and countries. For a comparative study to be useful and inform decision-making and policy formulation, a baseline common definition of key concepts and instruments used are very important. For example, how narrow or broadly biotechnology and biotechnology firms are defined in this study is critical. Thus, in order to generate better statistics for understanding the biotechnology industry and support evidence-based policy making, the Organisation for Economic Co-operation and Development (OECD) published *A Framework for Biotechnology Statistics* in 2005 in which it argues that a single and list-based definitions of biotechnology as advanced by the OECD *Ad hoc* Biotechnology Statistics Group should be used in a combination when designing surveys for collecting biotechnology data. An appropriate and consistent use of biotechnology and its defining elements will allow for international comparability of the data at any selected level of analysis.

The project's terms of reference has identified three levels of analysis for biotechnology capacity in the comparator countries including the macro, meso and micro levels. The different institutional classifications including business, government, higher education and non-profit sectors in undertaken and promoting biotechnology activities will be analyzed taking into consideration the institutional arrangements and the policy framework.

Another important methodological approach to be considered in the study is sectoral level of analysis. This will take into account the biotechnology sectors which the comparator countries have capacities and comparative advantages and how these were developed. Based on the agreed definition of biotechnology, these sectors could include agricultural and environmental biotechnologies, human health, industrial, services etc. For instance comparative study published in *Nature Biotechnology* in December 2004 looked at health biotechnology development and capacity in seven developing and industrializing countries including

Brazil, China, Cuba, Egypt, India, **South Africa** and South Korea. The broad biotechnology sector and industry in these countries can be considered. Indeed the 2001 *National Biotechnology Strategy* identifies these countries as some of which South Africa can learn something from, since they have developed significant progress in the development and commercialisation of biotechnology.

A third level of analysis will concentrate on the patterns and growth of individual biotechnology firms with selected case studies or recent success stories and failures.

Although the project concerns itself with national biotechnology profile we suggest that a small section will be included in the framework of analysis where regional or sub-regional policy development may have impact on infrastructure and capacity development in the biotechnology sector in these countries. This is because of the increasing relevance of science, technology and innovation programmes in regional economic co-operation and integration initiatives across the world, especially in the European Union through its pioneering Framework Programmes.

To undertake the study, we will combine qualitative and quantitative methods in order to provide the in-depth overviews of national policy instruments that foster biotechnological growth and performance in science and commercialization of biotechnology. The study will be conducted in three phases.

Phase 1: Current Status of Global Biotechnology

In this phase an overview of global biotechnology will be presented. The overview will take a reflective look at events that are shaping the industry. For, example one of the key drivers of international biotechnology is the expiration of patents of some products which has led to biogenerics and enable market entry of new players and has a bearing on costs. This overview will cover recent development in this sector such as market changes and convergence, competition, regulatory issues, and technological advancements and IP issues. Key challenges and competitive dynamics will be examined.

Information gathering and sources of information

An extensive desk top study will be undertaken to gather recent information on the current status of global biotechnology. Information will be gathered from various sources such as annual reviews by Ernst and Young, biotechnology industry associations and other relevant publications.

Phase 2: Development of Biotechnology Profiles of selected Countries

From the brief, is clear that from the list if topics to be included for each of the country case studies that a combination of statistical and narrative information needs to be collected and analysed.

The following is a list of countries is recommended for comparison. These countries were selected based on the following criteria

- Previous performance of the country based on international rating such as the 2002 European Innovation Scorecard (2003) , Biopolis report (2007), OECD Biotechnology Statistics, (2006)
- Size of the economy in comparison with South Africa
- Development state of the country
- Availability of published information on biotechnology for the country
- Country that has unique characteristics such as Cuba
- Regional location
- Countries that are same stage of development with South Africa and are competitors
- Countries that were used as case studies in the development of the National Biotechnology

List of Proposed countries

Country	Rationale for Selection
United Kingdom	Large industrialised country, stage of development of biotechnology sector advances, ranked among top countries internationally
Canada	'Medium to Large industrialised country, stage of development of biotechnology sector advances, ranked among top countries, part of the American region
Denmark	Small industrialized country, fast followers, highly ranked internationally

Switzerland	Small industrialized country, fast followers-emulated the leading countries well, highly ranked internationally
Finland	'Small industrialized country, fast followers, highly ranked internationally '
South Korea	Newly Industrialised Country, developed a well regarded sector
Singapore	Newly industrialized country, developed a well regarded sector
India	Developing Country, growing biotechnology industry especially in biogenerics and Foreign Direct Investment.
Brazil	Developing country with thriving biotechnology sector
Cuba	Highly regarded case study of poor country that has developed a highly regarded biotechnology sector – unique case

Information gathering and sources of information

For these case studies, we will rely extensively on country profiles of Biotechnology systems that have been published by individual countries. From these reports, condensed case studies that cover the key elements of each countries biotechnology system will be prepared. The case studies will cover the following elements bearing in mind the three different levels of analysis mentioned earlier, and their interactions and learning thereof. The following suggested template will serve as the output for this phase.

Introduction and background

- General introduction of the country
- Characteristics of national S&T and innovation system
- Contribution of biotechnology to economic and employment growth
- National support and framework conditions for biotechnology

Funding of biotechnology R&D, transfer and commercialisation

- Relative sizes of the biotechnology sectors
- Public funding and private funding of biotechnology research and commercialisation

- Instruments of relevant ministries
- Products, nature of key products, generation level and specialization
- R&D investment and employment (FTE)

Drivers of the Performance of the national biotechnology innovation system

- Performance in creating a knowledge base (publications and patents) and supporting the availability of human resources (human capacity development)
- Performance in knowledge transmission and application (new start ups, new products introduced to markets) and, facilities to conduct clinical trials
- Industrial development (creating of new enterprises and growth of existing and SME development), linkages of industry with universities, Foreign direct investment and relocation of companies to country
- Availability of new venture capital, angels, subsidies and incentives
- contract manufacturing and outsourcing facilities

Analysis and Main Findings

- Based on the available information, the strengths, challenges and constraints (e.g. legal, regulatory, human capacity, access to markets) of the country will be examined.
- The poor utilization or under utilization of available capacity
- Key competitive factors will be identified if these exist

Phase 3: Comparisons of Countries

To compare the biotechnology systems of selected countries, we will rely on comparative studies that have been conducted by OECD and Biopolis. Although these studies have methodological limitations, they are the most comprehensive reports that cover the key indicators in biotechnology. For example, the OECD report provides statistics for up to 23 OECD countries and 2 observer countries, plus China (Shanghai), based on the results of 33 separate studies. The main methodological challenges concern the production of comparable statistics across countries that have used different definitions and survey designs.

Some of the topics that will be examined in the comparison include the following:

- Comparison of national policies and their effectiveness
- Coordination of biotechnology among government departments
- Participation of industry (biotechnology associations,) and biotechnology networks
- Linkages between universities and industry (collaboration)
- Public understanding and participation in Biotechnology (NGO and lobbying groups)

The following are proposed indicators that will be used to compare the selected countries

- number of biotechnology firms,
- business expenditures on biotechnology R&D,
- biotechnology R&D in the public sector,
- biotechnology employment,
- sales of biotechnology goods and services,
- patents,
- Publications
- venture capital,
- GM crop hectares
- GM field
- main application fields.

Phase 4: Gap analysis of South African Biotechnology

In phase 4, a gap analysis will be carried out to identify the most significant areas of improvement the South African biotechnology sector by using an improvement matrix. The list will be prioritized and possible solutions will be recommended evaluated. Recommendations to policy makers will be made on the basis of the findings.

4 Project plan

In this section the project plan and the milestones are summarised.

4.1 Project Plan

The project will be conducted in four stages as displayed in the following table. The activities necessary to accomplish this study have been scheduled in a manner that considers the relationships and interdependence of the various work elements. The man-days that will be required to complete the various work packages and the outcomes are shown in the table.

PHASE	MAN-DAYS	OUTCOME
<p>PHASE 1 Desk research and identifying data sources</p> <p>1. 1 Gather relevant studies in Biotechnology such as biotechnology scorecards, OECD reports, Ernst & Young global biotechnology.</p> <p>1.2 Gather information on recent developments in Biotechnology such annual reports on state of biotechnology by Ernst and Young.</p> <p>1.3 Designing and drafting Country Template</p>	15	Global status of Biotechnology –focus on trends in biotechnology capacity internationally.
<p>PHASE 2 Biotechnology Capacity Profiles-(SA, Cuba, Switzerland, UK, India, Brazil)</p> <p>2.1 Develop Biotechnology capacity profiles of remaining countries.</p> <p>2.2 Review and finalise biotechnology capacity reports.</p>	65	Profiles of Selected Countries
<p>PHASE 3:Comparison of Capacity with South Africa</p> <p>3.1 Tabulation and comparison of capacity indicators from selected case studies. (quantitative)</p> <p>3.2 Identify qualitative biotechnology capacity indicators.</p> <p>3.3 Determination of benefits from various forms of capacity to biotechnology sector.</p> <p>3.4 Determine means of capacity development.</p> <p>3.5 Determine means of capacity acquisition.</p>	26	Comparative Study
<p>PHASE 4 Summary of Findings and recommendations</p> <p>4.1 Summary of Biotechnology Capacities that are important/increase competitiveness of sector.</p> <p>4.2 Identify capacity requirements in the</p>	14	Final Report

Biotechnology sector in South Africa		
4.3 Recommendations on strategies to improve capacity NACI		

The project as currently formulated can be completed in the time frame of four months. **The work could be initiated as soon as confirmation of this proposal has been received, with any modifications thereto, and is presently scheduled for the period as outlined above.**

4.2 Milestones

The following table is the milestone chart. Included in this milestone chart are feedback sessions to DST.

OUTPUT	MILESTONE
Completion of desktop research on global Biotechnology	1
Completion of development of profiles	2
Summary of findings and learning points	3
Submission of draft and Final Reports	4

5 Deliverable

The final report will be structured in four parts. Section A will provide background to the study, its objectives and the approach that was used to achieve its objectives. Section B will provide an overview of the comparison of the biotechnology systems. Sections C will present the main findings, dynamics in the industry and recommendations. The country profiles of case studies will be presented as separate reports comparisons between as many countries as possible. The second part is dedicated to country profiles.

6 Budgeted Costs

As described in Section 4 of this proposal, the study has been divided into five stages and different levels of the Work Breakdown Structure. The cost estimate to perform this study is shown in the following table. The figures show the labour costs and other resources necessary to accomplish the assignment. The man-days that are detailed in the implementation plan (Section 8) are considered. The total contract price for undertaking the project as outlined in the proposal is **R 495 620 including VAT.**

The cost estimate was developed based upon market prices for services provided to the public sector and includes a contingency of 10% of the total costs.

ITEM	COST	TOTAL
Labour costs for 4 researchers		
Dave Walwyn	R500 p/h for 14 days	R53 937
M. Madikizela	R495 p/h for 47 man days	R187 977
M. Ntwasa	R400 p/h for 22 man days	R70 737
F.Teng Zeng	R350 p/h for 37 man days	<u>R91 937</u>
		R404 586
Communication (telephone, faxing and internet use)	2250 p/m	R9 000
Local travel	R364 (for 140 km per meeting at R 2.6/km fro 5 meetings)	R1 820
Printing and Consumables	800 p.m	R2 400
Project Administration	2% of Total Costs	R8 514
	SUBTOTAL	
	VAT	R 69 300
	TOTAL	R 495 620

6.1 Assumptions and explanations

Labour (man-days)

The total man-days takes into account half days that will be spend as feedback meetings with NACI
 The labour costs are based on the following rates and will depend on the involvement of each individual on the project.

Labour costs for each phase (the major cost in the project)

Phase	Est. Cost	Est. % of labour costs
Phase 1	R53 320	13%
Phase 2	226 720	56%
Phase 3	R94 176	23%
Phase 4	R34 800	8%

Travel and accommodation

Local travel involves project meetings and feedback meetings with NACI.

Printing

The printing costs includes the printing of documents and reports for DST

6.2 Terms of Payment

DST will be invoiced at the conclusion of each milestone for payment. Payment will be expected at least 7 days after submission of invoice.

7 Project Team

7.1 Profiles and Roles of Project Team

Below is a table that shows the names of the project team, competency and their roles and contributions to the project. **The detailed C.V.s are appended (Appendix A)**

Competency Matrix

TEAM MEMBER AND KEY QUALIFICATION	YEARS OF PROFESSIONAL EXPERIENCE	CORE SKILLS	ROLE IN PROJECT
Dr Mziwandile Madikizela Ph. D in Biochemistry (University of Iowa) MBA (Wits Business School)	20 years experience in research management, Research experience in Molecular Biology, business management	Research and technology management, Science Policy, Technology management (auditing, assessment, roadmapping) Conducting surveys	Project Leader, Review of documents on international biotechnology, development of cases studies, comparison of biotechnology indicators, identify key learning points for South Africa, formulating of recommendations
Dr. David Walwyn Ph. D (Chemistry) Cambridge University	20 years experience in the chemical and biotechnology industries including policy studies, business incubation and technology development	Biotechnology policy, science and technology policy, research management, bioprocess development and business incubation	Collation of the final report , synthesis of the results, extraction of the main strategic learning points from the study for the client, and other input as required
Dr Monde Ntwasa B.Sc (Hons).Immunology Ph. D (Biochemistry) Cambridge University	20 years research experience in life sciences 10 years as academic Biochemistry	Senior lecturer Biochemistry (Molecular and Cellular Biology) GMO risk assessments GMO regulation and	Develop Case studies, identify areas of improvement in South Africa
Dr. Frank Teng Zeng MA (International Studies) D.Phil (Political Science) Stellenbosch University	9 years experience in science, technology and innovation policy and development research	National research and innovation systems Analysis development of science and technology indicators	Develop profiles, Policy analysis, Collect data on biotechnology indicators for comparative

<p>Mrs. Nomahlubi Shezi , B.Sc (Chemical Engineering),MIT B.Sc (Hon) Chem , UPTA Engineering Masters in Tech. Management (current studies)</p>	<p>8 years in Chemical Engineering,</p>	<p>Chemical engineering, management of technology, technology policy, research in medical implants and biomedical equipment</p>	<p>Compiling of Case Studies, collecting data for biotechnology performance indicators from information sources, tabulation of data and analysis</p>
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7.2 Relevant Experience in Biotechnology, Innovation Systems and Science Policy

Our project team has been involved in the following projects in Biotechnology

Development of Agricultural Biotechnology Strategy for the Department of Agriculture

Assisted the department in finalization of the strategy for Agricultural Biotechnology in South Africa.

Involved in improving areas such as animal health, biodiversity, ethics and cases studies. Strategy aimed at providing a framework for supporting developments in those areas consistent with the National Biotechnology Strategy and the National Research and Development Strategy. Furthermore, this strategy was designed to complement the broader strategic objectives of the National Biotechnology Strategy focusing in the **agricultural sector**.

Development of International Technology Transfer Strategy for BioPAD, the Biotechnology Regional Innovation Centre

BioPAD required an international technology transfer strategy in Biotechnology. The strategy was developed to assist the organization in the process of facilitating the inflow of appropriate technologies in its strategic focus areas. The output attempted to provide a model for technology transfer and guidelines (risks and pitfalls etc). Furthermore, competencies such as technology scanning, technology intelligence and auditing were developed by training an intern.

Development of Technology Roadmap in Agricultural Biotechnology for the National Department of Agriculture

The development of a technology roadmap for the sector was initiated as a follow up to the National Agricultural Biotechnology Strategy. This need driven process is used to can help identify, evaluate and select technology alternatives to satisfy the needs in an industry or organization. The

main benefit of technology roadmapping is that it will provide information to make better decisions for technology investment

Development of S&T profiles of selected Countries

In 2004, High Impact Innovation was commissioned by the Department of Science and Technology to compile Country case studies of their Science and Technology Systems. A key element of the study was to assess the Biotechnology performance of these countries. In total 30 countries (developed and developing) were profiled and the reports included a section on their Biotechnology systems especially key institutions and research focus areas.

The South African National System of Innovation: Structures, Policies and Performance

This work was undertaken by a team of people including Dr Walwyn, who was responsible for editing and presenting the final report.

Botswana National Research, Science and Technology Plan

The development of this plan, which included a detailed analysis of the existing research infrastructure in Botswana, was undertaken by a team of people from the CSIR, including Dr Walwyn.

The Development of Modern Biotechnology: Implications for Human Resource Needs in South Africa

This survey was undertaken by Dr Walwyn on behalf of the HSRC and included an in-depth analysis of the present and future human resource needs for South Africa

Biotechnology Roadmap for South Africa. Department of Science and Technology

The biotechnology roadmap was a project led by the Department of Science and technology and resulted in a plan of action for the department in respect of the biotechnology sector. Dr Walwyn was part of the team that compiled this report.

National Biotechnology Strategy

The National Biotechnology Strategy was the initial document that resulted in additional and specific support for biotechnology in South Africa. Dr Walwyn was part of the team that drafted this strategy.

Development of S&T Profiles of Selected African Countries

In 2006 HII in a joint tender with CREST (Centre for Research on Science and Technology, Stellenbosch University) was commissioned by the Department of Science and Technology to conduct a baseline profiles of 22 African Countries Science and Technology Systems. This project was completed in August 2007

White Paper on Science and Technology

This white paper was the first attempt ever in South Africa to create a single strategy for the support of science and technology in South Africa. Dr Walwyn was part of this team.

7.3 References

Below are a few references and projects that High-Impact Innovation has completed or is involved in. Some of the clients are listed in the company profile.

NAME OF REFEREE	Project	CONTACT DETAILS (Tel)
Dr Shadrack Moephueli Assistant Director General Department of Agriculture,	Consultant-Development of Agricultural Biotechnology Strategy, assisted the Directorate in drafting their strategy	Tel (012) 319 6536 Fax (012) 319 6329
Mr Butana Mboniswa CEO, BioPAD	Developed an International Technology Strategy for BioPAD	Tel (012) 483 2119 Fax (012) 483 2088
Dr Julian Jaffa Senior Manager Genetic and Resources Management Directorate Department of Agriculture	Development of Biotechnology Roadmapping in Agriculture	Tel (012) 319 6536 Fax (012) 319 6329
Mr John Steward (reference for Dr Walwyn) Member of NACI	Various projects including the preparation of NACI's report to the OECD on South Africa's national system of innovation	Tel: +27 11 7285116 Cell: +27 82 5680272
Dr Sibusiso Sibisi (reference for Dr Walwyn) CEO CSIR	Dr Walwyn worked for Dr Sibisi at the CSIR as the CSIR Research Manager for several years	Tel: (012) 841 2429
Dr Adi Paterson (reference for Dr	Various projects including the preparation of	Cell: (082) 498 9191

Walwyn) Member of NACI	the National Biotechnology Strategy and the White Paper on Science and Technology	
Dr F. Teng Zeng	Worked on NACI Commissioned project on "Optimising the Role of Science and Technology in Sustainable Development within the Context of NEPAD" First in 2004 and 2005 for short periods	NACI Secretariat

8 PROJECT IMPLEMENTATION PLAN

Assuming that the project will commence in as proposed in the ToR, the proposed implementation schedule is shown below. This Plan is designed to be illustrative; a detailed project Plan (MS Project) will be generated after the contract has been awarded

Activity	MM (md)	FTZ	MN	DV	Month 1	Month 2	Month 3	Month 4	Month 5
Desktop study on International Biotechnology Capacity –trends	5	0	0	0	—				
Development of template and draft profile	5	5	0	0	■				
Development of Country case studies (2 countries per person. DW to review and QC	20	20	20	5	■	■	■	■	
Comparison of Biotechnology Capacity (Qualitative and quantitative)	10	8	0	3				■	
Summary of Findings and Learning Points	3			3					■
Formulation of Recommendations	2	2	1	1					■
Presentation of Draft Report and Final Report	2	2	1	3					■
Total number of man-days	47	37	22	14					

Key: MM-M, Madikizela
 FTZ-Frank Teng Zeng
 MN- Monde Ntwasa
 DW-Dave Walwyn

Appendix A. CV's of Project Team

CURRICULUM VITAE:	MZIWANDILE MADIKIZELA
Nationality:	South African
Home Address	78 Letaba Street, Brackendowns, 1448
Tel (H)	011 868 3554
Business Address	19 Central Court, Moddercrest Office Park, JHB
Tel/Fax (B)	011 608 4881
Cell	082 659 2209
Email	mmadik@netactive.co.za
PROFESSION	Independent Consultant specializing in Science and Technology Director of Companies
KEY QUALIFICATIONS:	M.Sc. (Biochemistry), Ph. D. (Biochemistry). Masters in Business Administration (MBA) Certificate in Technology Management
EDUCATION	2000 M.B.A.-Wits Business School 1992 Ph.D. (Biochemistry)-University of Iowa, USA 1987 M.Sc. (Biochemistry) -University of Iowa 1984; B.Sc. (Hons, Biochemistry)-Uni. of Fort Hare 1981 B.Sc. (Chemistry and Biochem)- Uni. of Fort Hare
KEY SKILLS	<ul style="list-style-type: none"> • General management (strategy finance, operations, human resource and marketing) • Technology and Innovation Management • Research and Development Management • Technology licensing and marketing • Corporate Governance
EMPLOYMENT AND EXPERIENCE RECORD	<p>2003-PRESENT HIGH-IMPACT INNOVATION, Johannesburg, South Africa</p> <p>Director, management and innovation consulting services</p> <ul style="list-style-type: none"> ▪ Since 2003 has been consulting to government departments such as Department of Science and Technology, Department of Agriculture, Department of Health, Ntsika, DANIDA and NRF (Innovation Fund) and Support Programme for Industrial Innovation (IDC) and the Agricultural Research Council, BioPAD ▪ Business and Technical Evaluator for the Innovation Fund of the Department of Science and Technology ▪ Former Independent non-executive director-Onderstepoort Biological Products, a state owned manufacturer of animal vaccines-acting Chairperson of the Board in 2006

JULY 2000-2002 SASOL, LTD, Johannesburg

Technology Manager (Environmental), Sasol Technology

- Co-ordinated auditing, analysis and benchmarking of core technologies
- Co-ordinated future development of existing, emerging technologies and advise on investment decisions
- Facilitated strategic technology planning to achieve competitive advantage
- Co-ordinated the acquisition and transfer of technology between R&D and business units
- Developed intellectual property strategies for commercialisation of inventions

1997-2000 CHEMICAL SERVICES, TRANSNET, LTD, Johannesburg

Executive Manager (CEO)

- Strategic business planning using the Balanced scorecard as framework
- Financial planning and implementation to improve profitability
- Human Resource Strategy planning and alignment with organizational goals
- Formulated marketing strategies to increase market share
- Implementation of ISO 25 laboratory quality system

1995-1996 AECl, LTD, Johannesburg

Senior Research Scientist in Biotechnology

- Cloning of genes that are involved in biosynthesis of pharmaceutical products
- Expression of enzymes in bacterial expression vectors
- Review of patents and technology scanning
- Development of gene manipulation techniques
- Training of subordinates in research techniques in molecular biology

April 1993-1994 UNIVERSITY OF CAPE TOWN MEDICAL SCHOOL, Cape Town

Mellon Foundation Research Fellow,

- Conducted cancer research on regulation of expression of the collagen in transformed Hela cells

1991-MARCH 1993 BROWN UNIVERSITY, Rhode Island U.S.A

Post doctoral Research Fellow

- Conducted research on gene regulation of a candidate vaccine molecule in Schistosomes and expression of the protein in bacterial expression systems

MEMBERSHIP IN PROFESSIONAL ASSOCIATIONS

- Member of the International Association for Management of Technology, IAMOT
- Fellow of the Institute of Directors of Southern Africa (IoD)
- Member of the South African Research and Innovation Management Association (SARIMA)
- Member of the Black Management Forum (BMF)
- Member of International Development Evaluation Association (IDEA)

LEADERSHIP POSITIONS

Former Non-executive Director of Onderstepoort Biological Products –acting chairperson of the board in 2005/6 (Member of the Remuneration, Audit and R&D Board Committees)

Participant in the Foresight Initiative of the manufacturing sector initiated by Dept. of Arts Culture Science and Technology and co-chaired the Gauteng task team

Former Board member of National Laboratory Association (NLA)

Member of Task team that has recently completed a technology roadmap for Advanced Materials on behalf of the Department of Science and Technology

Former member of the ANC S&T working group in the Western Cape in 1993-1994

Member of the evaluation panel-CSIR Excellence Awards in 2005 and 2006

Member of Task Team that made recommendations to the Minister of Science and Technology based on the findings of the OECD Review of SANSI.

ADDITIONAL TRAINING

- Attended the Balanced Scorecard workshop conducted by D. Norton in 1999
- Expert Negotiator at Wits Business School in 1999
- Certificate in Technology Management from University of Pretoria (2001)
 - *Management of Technology*
 - *Strategic planning methodologies for technology-based organisations*
 - *Managing technological innovation for Competitive Advantage*
- Sasol Programme in Management of Technology offered by University of Pretoria
- International Business Consulting Skills by KPMG in 2002
- Director Development Course-Corporate Governance, Directorship and Board Effectiveness by Centre for Directorship and Corporate Governance in 2004
- Technology Roadmapping at Cambridge University, UK 2005

PUBLICATIONS

Suri, P.K., M. Goldberg, B. Chakraborty, K.B. Nguyen, R. Bungiro, Jr., **M. Madikizela**, M.M. Petzke, S. J. Davies, J.W. McCray, Jr. and P.M. Knopf. 1997. Evaluation of recombinant protein r140, a polypeptide segment of tegumental glycoprotein Sm25, As a defined antigen vaccine against *Schistosoma mansoni*. Parasite Immunology 19: 5515-1529

Malcolm Collins, Verna D. Leaner, **Mziwandile Madikizela** and M. Iqbal PARKER Regulation of the human $\alpha 2(1)$ procollagen gene by sequences adjacent to the CCAAT, Biochemical Journal. (1997) 322, 199–206,

Presented research posters at a number of international Conferences in Boston, MA (Infectious diseases in 1992), Woodshole, MA (Molecular Parasitology, 1992) and Stellenbosch (Biochemistry, 1993)

CURRICULUM VITAE:	DAVID WALWYN
Nationality:	South African
Home Address	24 Osborn Road, Victoria, 2192
Tel (H)	011 728 4784
Business Address	c/o eGoli BIO, PO Box 398, Modderfontein, 1645
Tel/Fax (B)	011 605 9107
Cell	082 416 1534
Email	dwalwyn@arvir.co.za
Profession	CEO, Arvir Technologies
EDUCATION:	
1982	Ph.D. (Chemistry), Cambridge University
1979	B.Sc. (Chemical Engineering), UCT
RELEVANT EXPERIENCE:	
<p>I have undertaken the following policy initiatives, surveys and studies of relevance to this assignment:</p> <p>Walwyn, D (ed). 2006. The South African National System of Innovation: Structures, Policies and Performance. NACI, Pretoria.</p> <p>Keatimilwe, K, D Walwyn et al. 2005. Botswana National Research, Science and Technology Plan. CSIR.</p> <p>Walwyn, D. 2004. The Development of Modern Biotechnology: Implications for Human Resource Needs in South Africa. Chapter 25 of the HSRC Biennial Directory. HSRC Press, Cape Town</p> <p>Walwyn, D, J Webster, J Morris and C du Preez. 2003. Biotechnology Roadmap for South Africa. Department of Science and Technology.</p> <p>Walwyn, D, J Gordon-Lennox, H Laing and W Basson. 2002. Proposed Technology Interventions for the South African Chemical Industry. National Council on Innovation (part of the Advanced Manufacturing Strategy).</p> <p>Walwyn, D and co-authors. National Biotechnology Strategy. 2001. Department of Arts, Culture, Science and Technology.</p> <p>Adam, R, M Singh, D Walwyn and M Mullins. 1996. White Paper on Science and Technology. Department of Arts, Culture, Science and Technology.</p> <p>Walwyn, D and 14 co-authors. 1995. Green Paper on Science and Technology. Department of Arts, Culture, Science and Technology.</p> <p>In addition, whilst CEO of the eGoli BIO incubator, I managed the biotechnology audit and have extensive knowledge of biotechnology industries, both local and international.</p>	
KEY SKILLS:	
<p>Research, technology and innovation management</p> <p>Science policy including formulation, monitoring and evaluation</p> <p>Biotechnology research and development, especially in antiretrovirals and drug discovery</p> <p>Bioprocessing technology</p> <p>Commercialisation of biotechnology</p> <p>Business incubation</p>	

Technology valuation
Research funding and evaluation
Intellectual property protection and management

EMPLOYMENT AND EXPERIENCE RECORD

2007-PRESENT ARVIR TECHNOLOGIES (PTY) LTD, Johannesburg, South Africa

Chief Executive Officer

Arvir is a start-up biotechnology company which has been established to build a local antiretrovirals business through the manufacture and drug discovery. I am responsible for setting up the company, developing its strategy, and attempting to realise its primary goal which is to build a local ARV API manufacturing entity in order to lower the cost and ensure the supply of ARVs to the South African ARV treatment programme.

2004 – 2007 CSIR

Group Manager: Research and Development

I was responsible for the management of the CSIR's strategic research portfolio (mainly projects funded by Parliamentary Grant; R450 million in 2006/7); development of CSIR S&T strategy; identification of emerging research areas; establishment of new research groups in areas of future importance; providing strategic advice to Executive on S&T trends and opportunities for investment; monitoring of SET excellence in the organisation; promotion and development of research; establishment of linkages with other research organisations including universities and international public research institutions. My activities included the establishment of a comprehensive evaluation system based on science and technology outputs across the entire span of the research and innovation value chain; more rigorous research management procedures to ensure both ex-ante and ex-post peer evaluation of research projects; the establishment of a new research groups in nanoscience, intelligent autonomous systems and synthetic biology; and the development of new systems for portfolio management within the institution.

1999 – 2004 CSIR Bio/Chemtek

Various positions including Business Development and Innovation Management. In broad terms I was responsible for the management of innovation in the division, including technology management, business development, marketing and communications, strategic initiatives, finding and securing third party funding for the division, and partial responsibility for intellectual property protection and management.

1988 – 1999 AECI Research and Development Department

Group Leader: Process Development, Lysine Technology Development Manager and Responsible Engineer. I was responsible for managing the activities of about 50 scientists, operators and engineers, who were involved in aspects of scale-up and technology development. Annual budget about R6 million operating expenditure and R2 million capital expenditure. Areas of expertise include the techno-economic evaluation of projects, process design, mathematical modeling of bio/reaction and bench-scale engineering for scale-up design, managing two pilot plants on the site and ensuring that these comply with the relevant safety legislation.

1985 – 1988 Natal Cane By-Products, Durban

Production Engineer. I was responsible for the solution of technical problems on a variety of chemical plants, for instance the optimisation of yeast production and substrate utilisation, the removal of impurities from fermentation off-gases by scrubbing and from potable alcohol by distillation. The company's products included potable alcohol for the food and pharmaceutical industries, a variety of industrial alcohol blends, diethyl ether, mannitol/sorbitol, food yeast, animal feed, carbon dioxide, vinegar and spice powder.

MEMBERSHIP OF PROFESSIONAL ASSOCIATIONS:

South African Institution of Chemical Engineers (1988 – 2002)

LEADERSHIP POSITIONS:

Existing

Member of the Intellectual Property and Technology Transfer Advisory Group, CSIR

Member of the Medicines Control Council

Member of the Biovac Institute Research Advisory Committee

Director (Non-Executive) of Pelchem (Pty) Ltd

Previous

Member of the Board of the Technology and Human Resources in Industry Programme (THRIP)

Member of the Board of eGoli BIO Life Sciences Incubator (resigned in May 2005)

Member of the National Laser Centre's Research Advisory Board (resigned in August 2005)

OTHER APPOINTMENTS AND TRAINING:

2006 - PRESENT

Extraordinary Professor in the Department of Engineering and Technology Management, University of Pretoria.

RELEVANT PUBLICATIONS:

Walwyn, D. 2007. A New Framework for the Performance Management of Research in Higher Education Institutions. Article submitted to the South African Journal of Higher Education, January 2008

Walwyn, D. 2007. An Analysis of the Performance Management of South African Higher Education Institutions. Article submitted to the South African Journal of Higher Education, January 2008.

Walwyn, D. 2007. A Comparison of the Cost of Research in South Africa's Public Research and Higher Educational Institutions. Submitted for publication. South African Journal of Science.

Walwyn, D. 2007. A Target for South Africa's Business Expenditure on Research and Development Based on Industry Structure. Submitted for publication. South African Journal of Science.

Walwyn, D. 2007. Finland and the Electrical Goods Sector; A Case Study of the Return on Investment from Public and Private Research. Technovation; The International Journal of Technological Innovation, Entrepreneurship and Technology Management, 27; pp 335 – 341.

Walwyn, D and T White. 1998. The challenge for innovators in the South African chemical industry. Chemical World. October: 26 - 31.

Walwyn, D and B Scholes. 2006. The Impact of a Mixed Income Model on the CSIR: a Recipe for Success or Disaster? South African Journal of Science, 102; pp 239 - 243.

Walwyn, D. 2006. Macro-Economic Measures for the Return on Investment in Innovation. Chapter 6 of 'Measuring Innovation in OECD and non-OECD Countries', HSRC Press, Cape Town

Walwyn, D. 2005. Selecting the Most Appropriate Commercialisation Strategy is Key to Extracting Maximum Value from Your R&D. International Journal of Technology Transfer and Commercialisation, 4(2); pp 162 - 171.

Walwyn, D. 2004. A Comparative Study on the Influence of the Cost and Availability of Capital on the Development of National Biotechnology Industries. Int. J. Biotechnology, 6(1); pp 55 – 64.

Walwyn, D. 2004. The Development of Modern Biotechnology: Implications for Human Resource Needs in South Africa. Chapter 25 of the HSRC Biennial Directory. HSRC Press, Cape Town

Walwyn, D, D Taylor and G Brickhill. 2002. How to Manage Risk Better. Research Technology Management, 45(5); pp 37 – 42.

Walwyn, D. 1992. A techno-economic study of the production of polysaccharide by *Porphyridium aerugineum*. SA Journal of Chemical Engineering. 4:1-18.

Walwyn, D. 1990. The role of mathematical models in the optimal control of bioreactors. SA Journal of Chemical Engineering. 2:41-64.

NAME: Monde Ntwasa
Profession: Senior Lecturer in Biochemistry
Proposed position in Team:
FIELDS OF SPECIALISATION: Molecular Biologist
NATIONALITY: South African
KEY QUALIFICATIONS <ul style="list-style-type: none"> • Research in molecular biology of cancer and immunity • Active Participant in Biotechnology policy for a • Reviewer: National Department of Agriculture: GMO (Genetically Modified Organisms) • Member of the Subcommittee on Genetically Modified Organisms
EDUCATION AND PROFESSIONAL STATUS
EDUCATION
1996 Ph.D. (Biochemistry)-University of Cambridge
1988 B.Sc. Medicine (Hons, Clinical Science and Immunology)-University of Cape Town
1980 National Dip. Med. Tech. (King Edward VIII, Durban)
MEMBERSHIP IN PROFESSIONAL ASSOCIATIONS
(a) Member of the American Society for Biochemistry and Molecular Biology (ASBMB) 1996 - 2001
(b) Member of the American Association for the Advancement of Science. (AAAS)
(c) Chairperson and member of the Experimental Biology Group (EBG) (1998)
(d) Founder - member of the Molecular & Cell Biology Group (MCBG)
Recent experience
1999 – Lecturer then Senior Lecturer: School of Molecular & Cell Biology. Wits University.
1996 – 1999 research Fellow. Department of Anatomy & Cell Biology. University of Cape Town Medical School
PUBLICATIONS
1. Mather A, Rakgotho M, Ntwasa M. (2005). SNAMA, a novel protein with a DWNN domain and a RING finger-like motif: A possible role in apoptosis. <i>Biochim Biophys Acta.</i> 1727/3 pp. 169-176
2. Ntwasa, M., S. Aapies, D Schiffmann and N.J. Gay (2001). <i>Drosophila</i> Embryos Lacking N-Myristoyltransferase Have Multiple Developmental Defects. <i>Exp. Cell. Res.</i> 262 pp 134-144
3. Ntwasa, M., M. Egerton and N.J. Gay (1996). Sequence and expression of <i>Drosophila</i> N-myristoyl-CoA protein N-myristoyltransferase: evidence for membrane localisation. <i>J. Cell Sci.</i> 110 pp 149
4. Ntwasa, M , S.G. Buchanan ad N.J. Gay(1994). Sequence and expression of LRR47, a novel embryonic leucine rich repeat protein of <i>Drosophila</i> <i>Biochim et Biophys Acta (Gene Structure).</i> 1218 (2) 181-186.

5. **Ntwasa, M., S.G. Buchanan and N.J. Gay (1994).** *Drosophila* ribosomal protein L18a: cDNA sequence, expression and chromosomal localisation of the gene *Biochim et Biophys. Acta (Gene structure)*. **1218** (2) 210-213.
6. **Gay, N.J. and Ntwasa, M (1993).** The *Drosophila* ankyrin repeat protein CACTUS has a predominantly alpha-helical structure. *FEBS letters*. **335** (2) 155.

CURRICULUM VITAE:		FRANK KANNIGENYE TENG-ZENG	
Nationality		Ghanaian	
Home Address		4 La Casa Mathew Road, Claremont, Cape Town	
Tel (H/)		021 6834769	
Business Address		C/O Post Office Box 12981 Mowbray 7705	
Tel (H/W):		021 6834769	
Cell		082 365 9363	
E-mail		fktengzeng@hotmail.com	
PROFESSION		Consultant and Policy Analyst Science, Technology and Innovation Studies	
KEY QUALIFICATIONS:			
December 2002		DPhil (Political Science)- Stellenbosch University, South Africa	
March 1999		MA (International Studies)- Stellenbosch University, South Africa	
June 1996		BA (Hons, Sociology)- University of Ghana, Legon, Ghana	
MEMBERSHIP IN PROFESSIONAL ASSOCIATION			
<ul style="list-style-type: none"> a. South African Association for Research and Development in Higher Education (SAARDHE) b. Member of the Southern African Universities Social Sciences Conference (SAUSSC). c. Africa Institute of South Africa (AISA). d. AFRICALICS Network of GLOBELICS (Global Network for the Economics of Learning, Innovation and Competence-building System) 			
SKILLS TRAINING			
<p>Participated in three formal Modules in the field of Science, Technology and Innovation Policy Studies including Science Policy Studies, Philosophy and Sociology of Science and Research Management in 2003. An introductory training course in Scientometrics in February 2004 and follow up to this course in March 2005.</p>			
EMPLOYMENT AND EXPERIENCE			
<p>2008- Research and Innovation Consultancy Services Unit (planning in-progress). Working on Regional Innovation System Framework for Eastern Cape Province with High Impact Innovation</p>			
<p>MAY 2004-2007 Post-doctoral Research Fellow, Centre for Research on Science and Technology (CREST), Stellenbosch University, South Africa</p>			
<p>AUGUST 2003-JANUARY 2004 Contract Research for National Advisory Council on Innovation (NACI), South Africa</p>			
<p>JUNE 2002- JULY 2003- Postdoctoral Research Assistant Centre for Interdisciplinary Studies (CENIS), University of Stellenbosch, South Africa</p>			

AUGUST 1996-NOVEMBER 1996-Research Assistant Ghana National Service Scheme: Non-Formal Education Division
Bechem, Ministry of Education Ghana

PUBLICATIONS

1. Nel, P & F Teng-Zeng (2003). "Science and technology in Sub-Saharan: Regional Co-operation in a Post-national Environment", *African Insight* 33(3): 28-36.
2. Davidson, OR & F Teng-Zeng (2003). Transfer of emerging energy technologies: Technology agreements in the context of climate change. *Asia Pacific Tech Monitor* Nov-Dec 2003, 20(6): 15-23.
3. Teng-Zeng FK (2005). "The Same Story or New Directions? Science and Technology Within the Framework of the African Union and New Partnership for Africa's Development", *Science and Public Policy* June 32(3): 231-245.
4. Teng-Zeng FK (2005). "The Same Story or New Directions? Science and Technology Within the Framework of the African Union and New Partnership for Africa's Development" In: Gloria Jacques and Gwen N Lesetedi (eds.) *The New Partnership for Africa's Development: Debates, Opportunities and Challenges*. Pretoria: Africa Institute of South Africa. Chapter 16, pp.249-281.
5. Teng-Zeng FK (2006) "Science, Technology and Institutional Co-operation in Africa: From Pre-colonial to Colonial Science", *Eastern Africa Social Science Research Review* January 22(1): 1-37.
6. Teng-Zeng FK (2006). "Industrial Research and Development and Tax Incentive Policies: A Survey and Lessons for Africa", *The African Finance Journal* 8(Part 1): 39-58.

Popular and Briefing Articles

7. Botswana Science and Technology: A Brief Profile, *Research Africa*, 24 October 2006, p19.
8. Ghana Science and Technology: A Brief Profile, *Research Africa*, 21 November 2006, p19.
9. Senegal Science and Technology: A Brief Profile, *Research Africa* Issue, 20 February 2007, p19.
10. Tanzania Science and Technology: A Brief Profile, *Research Africa*, 22 May 2007, p19.
11. More than Numbers (Science Ministries in Africa) *Research Africa* Issue 23 October 2007, pp20-21.

Commissioned/Technical Project Reports

12. Davidson, OR & F Teng-Zeng (2003). Capacity-Building in the Development and Transfer of Technologies. Technical Paper Commissioned by Secretariat of the United Nations Framework Convention on Climate Change, Bonn Germany. UNFCCC Publication FCCC/TP/2003/1 26 November 2003.
13. Teng-Zeng, FK (2003). Report on National Innovation Systems of Some Selected Countries (CENIS project, Draft Report Completed April 2003).
14. Teng-Zeng, FK (2004) Optimising the Role of Science and Technology in Sustainable Development within the Context of NEPAD (NACI commissioned project, Draft completed March 2004).
15. Teng-Zeng, FK (2004). *Science, Technology and Inequality: An Agenda for Research*. A Draft Project Report for the

National Advisory Council on Innovation (NACI) & CREST, South Africa. May 2004.

16. Teng-Zeng, FK (2005) Optimising the Role of Science and Technology in Sustainable Development within the Context of NEPAD (NACI commissioned project, Up-bridging Report July 2005).
17. Teng-Zeng Frank and Mouton Johann (2006) National Innovation System in the Context of Socio-economic Transformation in Africa. Background Paper for Africa PRIME Workshop held at CIRCLE, Lund University, Sweden from 23rd-24th January 2006.
18. Science and Technology in Botswana: Country Profile. CREST (Centre for Research on Science and Technology), University of Stellenbosch Draft Report for South African Department of Science and Technology Commissioned African Science and Technology Profiles, 15 August 2007. Also see a version in: Johann Mouton and Roland Waast (compiled and edited) *Study on National Research Systems: A Meta-Review*. The UNESCO Forum on Higher Education, Research and Knowledge, Profiles of Countries in Africa, November 2007.
19. Science and Technology in Ghana: Country Profile. CREST (Centre for Research on Science and Technology), University of Stellenbosch Draft Report for South African Department of Science and Technology Commissioned African Science and Technology Profiles, 15 August 2007. Also see a version in: Johann Mouton and Roland Waast (compiled and edited) *Study on National Research Systems: A Meta-Review*. The UNESCO Forum on Higher Education, Research and Knowledge, Profiles of Countries in Africa, November 2007.
20. Science and Technology in Senegal: Country Profile. CREST (Centre for Research on Science and Technology), University of Stellenbosch Draft Report for South African Department of Science and Technology Commissioned African Science and Technology Profiles, 15 August 2007. Also see a version in: Johann Mouton and Roland Waast (compiled and edited) *Study on National Research Systems: A Meta-Review*. The UNESCO Forum on Higher Education, Research and Knowledge, Profiles of Countries in Africa, November 2007.
21. ECOWAS Regional Science and Technology Profile. CREST (Centre for Research on Science and Technology), University of Stellenbosch Draft Report for South African Department of Science and Technology Commissioned African Science and Technology Profiles, 15 August 2007.
22. Mouton, J., Boshoff, N., Kulati T., and Teng-Zeng, F. (2007). Scientific Mobility and the African Diaspora. James Martin Institute Working Paper 6, April 2007. Project Deliverable #4 under Work Package 2 of ResIST- Researchingth Inequality through Science and Technology- a STREP (contract CIT5- CT-2006-029052) under Priority 7 of the 6th Framework Programme: Citizens and Governance in a Knowledge-Based Society, European Commission.
23. The Status of Science, Technology and Innovation Policies in Africa: A synoptic overview. CREST for Research Africa, July 2007.

SHORT CV SUMMARY

Frank Teng-Zeng obtained his doctoral degree in Political Science from University of Stellenbosch, South Africa in 2002. He also holds a Masters degree in International Studies from the same University awarded in 1999, and completed his undergraduate studies (BA Honours degree) in Sociology at the University of Ghana, Lagon in 1996. His dissertation at the doctoral level is entitled "Transnational Science and Technology Co-operation in Africa: An Evaluation of Selected Institutions and Programmes".

He has work on projects including: "Capacity-Building in the Development and Transfer of Technologies", Commissioned by Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC), Bonn Germany in 2003; "Optimising the Role of Science and Technology in Sustainable Development within the Context of NEPAD (commissioned by South African National Advisory Council on Innovation (NACI) in 2003 and 2005); and the Africa PRIME Network Project- Research on National Innovation Systems in Developing Countries 2005. He was involved in SARIMA-Research Africa Project supported by

DFID, UK; Researching Inequality through Science and Technology (ResIST) funded by the European Commission (with initial support from DST, South Africa) by looking at Scientific Mobility and the African Diaspora; Twenty-two African Countries Science and Technology Profiles commissioned by DST, South Africa in 2006; and The Africa Science & Technology Indicators and Mapping Project- an initiative of CREST and CWTS at Leiden University.

Teng-Zeng has published and presented papers at international and national conferences including an invitation to present at the Science Forum of the World Summit on Sustainable Development (WSSD) held in the Republic of South Africa in August 2002; the New Partnership for Africa's Development (NEPAD) Conference *Conditions for Maximising S&T to NEPAD Process*, organized by South Africa's National Advisory Council on Innovation (NACI), Eskom Convention Centre, Midrand, South Africa, in October 2002; and invited discussant on Regional Profile on Sub-Saharan Africa- *Symposium on Comparative Analysis on National Research Systems*, organised by UNESCO Forum on Higher Education, Research and Knowledge, UNESCO Head Office, Paris, France in January 2008.

His current research interests include National Innovation Systems focusing on S&T human resource development and research at Higher Education Institutions, financing R&D, tax incentive and technological innovation issues; Science, technology and development; Research and transfer of environmentally sound technologies; Science, technology and foreign policy; Multilateral and bilateral institutions in the development of S&T in Africa.

He is working with High Impact Innovation on Regional Innovation Systems Case Study in the Eastern Cape Province in South Africa and independently looking at scientific mobility and National Innovation System Competitiveness in South Africa and African Higher Education Research and Postgraduate Training Network mapping project as well as Science, Technology and Innovation Indicators Development in Africa.

<p>NAME: NOMAHLUBI SHEZI</p>
<p>FIELDS OF SPECIALISATION:</p> <ul style="list-style-type: none"> Commercial Refining Design Engineering Production Business Development and Planning Monitoring and Evaluation of Projects Strategic planning Technology and Innovation Management
<p>NATIONALITY: South African</p>
<p>EDUCATION AND PROFESSIONAL STATUS</p> <ul style="list-style-type: none"> B.Sc Eng (Chemical) Massachusetts Institute of Technology, USA B.Eng (Hons in Management of Technology), University of Pretoria M.Eng (Technology Management), University of Pretoria (Current) <p>MEMBERSHIP IN PROFESSIONAL ASSOCIATIONS</p> <ul style="list-style-type: none"> Was a member of the National Society of Black Engineers (NSBE) Was a member of the American Institute of Chemical Engineers (AIChE)
<p>RECENT EXPERIENCE</p> <p>PSIDOT ENGINEERING, Johannesburg, South Africa</p> <p>Senior Consultant</p> <p>Involved in project evaluations for the SPII fund sponsored by the Department of Trade and Industry. Also involved in new business development.</p> <p>JULY 2000 - DEC 2004 SASOL TECHNOLOGY, Johannesburg</p> <p>Senior Process Engineer – Concept Development Dept</p> <p>Was responsible for conceptual design of new projects in the olefins and surfactants environment. This included flowsheet preparation and simulations. Provided technical support during basic engineering, plant commissioning and start-up until plant produced the required product. Also provided licensor support during commissioning and start-up. Involvement with hazop's and model reviews before project implementation. Liaising with research and development for piloting and design data collection. Sourcing and evaluating available technologies.</p> <p>Successfully commissioned detergent alcohols (da) plant in Secunda in 2002. Completed a conceptual engineering package of the da train two project in which she was a lead engineer. This involved a techno-economic evaluation of two different technologies. Cost estimation and economic calculations were performed for these technologies.</p> <p>Was nominated in 2003 for the engineering design seminar hosted by up in Chicago.</p> <p>Also involved in the conceptual design of the heptene to octene project where she was responsible for the impact of this new project on the existing Secunda complex. She was also responsible for the planning and co-ordination of a project for the utilization of an existing hexene train 2 plant to produce heptene.</p> <p>In 2004 was responsible for the power generation study within the Coal-to-liquids (CTL) project in China and USA. This project was at the pre-feasibility stage therefore she was evaluating technical and economic feasibility of power production. Supervised and mentored vacation students and newly graduated engineers.</p> <p>JAN 1999 - DEC 1999 SHELL SOUTHERN AFRICA, LTD, Cape Town</p> <p>Business Analyst – Manufacturing, Supply & Distribution Dept</p>

Was responsible for evaluating SAPREF's capital project proposals by understanding project focus, cost vs. benefit and viability for Shell's share. Daily produced refinery margins to the department and for the refinery economist to optimize the refinery performance. On a weekly basis, monitored and appraised SAPREF production vs. Shell nomination. Also assisted in the implementation of HSE policies through regular monitoring of the refinery performance. Updated knowledge of global HSE policies/ requirements and potential application to local environment.

FEB 1998 – JAN 1999 SHELL & BP SOUTH AFRICAN PETROLEUM REFINERY, Durban

Environmental Technologist – Technology Dept

Was responsible for refinery emissions such as volatile organic compounds from the storage tanks and sulphur dioxide. This included auditing of SO₂ and using HAWK model for predictions and daily interpretation of results. Also used FRED (Fire Release Explosion Dispersion) model for advice during drills and emergencies. Also provided technical support to operations on Sour Water Stripper Units and control of effluent water quality.

Massachusetts Eye and Ear Infirmary

Aug 1994 – Dec 1994

Cambridge, Massachusetts

RESEARCH ASSISTANT

Assisted Prof. Andy B. Dobrzeniecki collect and analyze data for research in cochlea implant. Debugged a C program used in this research. Prepared cochlea slides for microscope use and worked with MRI's CT scans.

Massachusetts Institute of Technology

May 1994 – Jun 1994

Cambridge, Massachusetts

RESEARCH ASSISTANT

Assisted Prof. Dobrzeniecki in his research on medical image processing. C programming in conjunction with Xview program was used to enhance picture pixels in MRI's and CT scans

Appendix B: Relevant References

1. Biopolis – Inventory and analysis of national public policies that stimulate research in biotechnology, its exploitation and commercialisation by industry in Europe in the period 2002-2005, March 2007
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7. European Union, 2005, New Perspectives on the knowledge based Bio-economy, Conference Report
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9. Halla M. F, et al 2004, Cuba —Innovation through synergy, Nature Biotechnology, Volume 22
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14. OECD, 2006: Biotechnology Statistics In OECD Member Countries: An Inventory STI Working Paper 2004/8 Statistical Analysis Of Science, Technology And Industry
15. The Swedish Biotechnology Innovation System, VINNOVA Innovation in Focus VF 2001:2
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17. Wong,, J et al, South Korean biotechnology—A rising industrial and scientific powerhouse, 2004, Nature Biotechnology, Volume 22

Appendix C. Profile of High Impact Innovation

HIGH-IMPACT INNOVATION and Associates cc

Tel: (011) 608 4881

Cell: 082-659 2209

Fax: 011 608 4881

Email: mmadik@netactive.co.za

Physical Address

19 Central Court

Moddercrest Office Park

Modderfontein

1645

COMPANY PROFILE

Every organisation ...needs one core competence; innovation. And every organisation needs a way to record and appraise its innovative performance

Peter F Drucker, HBR 1995

STRATEGIC GOALS:

Our primary goals are:

- To assist companies to maximise their financial performance through focused market development and growth
- To promote technological innovation and increase the competitiveness of organisations
- To raise the professional standards of business practice

BACKGROUND

High-Impact Innovation offers consulting services in business and technology management. We offer a unique blend of skills, which enables us to work effectively with companies in their drive for growth and competitiveness.

SERVICES

High-Impact Innovation offers a range of services to companies and government departments in five broad areas

- **Technology and Innovation Policy analysis**

Our expertise includes studies that are designed to develop and understand the institutions and mechanisms supporting technical innovation in countries. Technological advance proceeds through the interaction of many actors. Our methodology is intended to illuminate the similarities, differences across countries and how they contribute towards competitiveness. This includes an analysis of government policies that are aimed at stimulating innovation, the major institutional actors, the allocation of R&D activity, the characteristics of firms and important industries, and the role of universities.

- **Innovation and Technology Management**

We advise clients on the quality and potential of their technology, giving an objective view in relation to their marketplace and competition, helping to define strategy and find ways to compete by using technology more effectively.

We help clients to find and implement breakthrough ideas for new products, new services and new business ventures. Using well-established methodologies, we work with clients to create the optimum product or service portfolio. We can then apply our skills to bring the results to market quickly and with minimum risk

- **Business Improvement**

Many companies realize that they are not operating as efficiently and effectively as they could. High Impact Innovation provides an independent Business Process Review (BPR) that assesses the efficiency and effectiveness of administrative, financial and operational business processes, and we will evaluate the alternatives. A high level analysis is conducted by discussions with management. Optionally, a more detailed analysis is conducted based on interviews with key personnel. The detailed analysis is recommended when management is unsure of the nature and extent of existing problems. The objective of the BPR is to identify opportunities for business process improvement, which are identified and evaluated from a business case perspective. The detailed analysis will lead to a more accurate business case.

- **Monitoring and Evaluation of Programmes and Projects**

We conduct careful examination and analysis of an on-going or completed project. The evaluations usually include examination of the project design (goals and plans), implementation (inputs and outputs) and results (effects and impacts). Typically, evaluations look at project efficiency, effectiveness, sustainability and relevance. Attention is paid to both intended and unintended results, and to factors affecting the level and distribution of any benefits produced. The main purpose of evaluation is to guide decision-makers.

In monitoring projects, we collect, analyse and use information to guide project implementation.

- **Facilitation**

We provide out-come driven facilitation to help teams achieve superior results. Our visual mapping process is suitable for numerous types of workshops including strategic planning, role clarification and problem solving sessions. The advantage of our visual mapping process is that it ensures maximum participation by all participants. The participative nature of the process contributes to buy-in and alignment resulting in commitment to the outcome of the workshop. The outcome process is suitable for development of vision, mission and values, strategic planning, objective setting, client need analysis and project management.

- **SMME Innovation Support**

SMMEs are regarded as crucial to economic development, competitiveness and job creation. However, they face considerable challenges such as limited resources (research infrastructure, skills) increased competition, globalization and access to new technologies to name a few. Our aim is to help SMMEs

through improvements in product, process, technology and business practice. Our structured process is designed to examine all aspects of the business.

APPROACH

We have assembled a blend of tools to effectively meet the increasing challenges facing most organisations. Our proven methodologies are designed to provide you with solutions to meet each of your unique challenges. To deliver our solutions, High-Impact Innovation has established a network of associates in a variety of disciplines locally and overseas who bring together expertise in the area of business

INDUSTRY SPECIALISATION

High-Impact Innovation offers services to the following sectors

- Small to Medium sized enterprises
- Private sector focusing on Biotechnology-food, agriculture and environment
- Universities and technikons to build research capacity and links with industry
- Government department such as Health, Science and Technology, Trade and Industry, Environmental Affairs and Tourism and Agriculture
- Science councils and parastatals
- Government agencies and organizations who are involved in community development projects

BENEFITS OF USING HIGH-IMPACT INNOVATION

Hands on approach and intimate involvement of consultant in organisational challenges

- Participation of company employees in identifying problems
- Developing solutions and implementing in partnership with High-Impact Innovation
- Sound advice and cost effective solutions
- Common sense approach that emphasises asking the right questions

FEE STRUCTURE

High-Impact Innovation offers a flexible system in order to accommodate the various needs of our customers in different scenarios. The following mechanisms can be negotiated:

Retainer: A monthly payment for agreed level of ongoing consulting input and guidance. This is suitable for advisory positions, low touch input on a project, or even ad-hoc but often urgent advice

Fee for service: An agreed flat fee for an agreed deliverable for a specific project

MANAGEMENT TEAM

Dr. Mziwandile Madikizela (Director of High Impact Innovation) completed his B.Sc. (Hons) in Biochemistry from the University Of Fort Hare. Thereafter he did his MS and Ph.D. degrees in Biochemistry at the University of Iowa in the US. He has since completed an MBA from the University of Witwatersrand and a Certificate in Technology Management from the University of Pretoria. Upon completing his Ph.D., he

did his first postdoctoral research fellowship at Brown University in Rhode Island followed by a second postdoctoral fellow at the University of Cape Town Medical School. Between 1995 and 1996 he was a Senior Research Scientist in Biotechnology at AECI. In 1997 he was appointed as Executive Manager of Chemical Services, a business Unit of Transnet that provided environmental analytical and consulting services. Thereafter he joined Sasol as an Environmental Technology Manager until Feb 2003.

Dr Madikizela was a member of the ANC's Science and Technology working Group in the Western Cape. In 1998 he was part of the Foresight Task team for the manufacturing sector, an initiative of DACST. In 2001 he participated in the Manufacturing Technology Roadmapping exercise that was commissioned by DST.

Currently he provides advisory services in science policy, technology and society, technology management mainly to government departments (DST, DoH and DoA)

ASSOCIATES

DR MLULEKI NKWELO holds an M.Sc. (University of Fort Hare) and Ph. D (University of Witwatersrand) degree in Chemistry. He is currently a senior lecturer in Chemistry at the University of Pretoria where he teaches organic and general chemistry. Before joining this institution, he was the acting head of the Department of Chemistry at Vista University between 2001 and 2002. His responsibilities included running the sub departments in Pretoria, Johannesburg and Port Elizabeth.

In 1994 he joined CSIR as a research scientist and was responsible for the development of various household products. He then did research on polymers until he left in 1996. Before joining CSIR he was a R&D Chemist for Black like Me between 1992 and 1994. He was responsible for the maintenance of all existing products by regular review of raw materials to identify possible cost saving, planning and monitoring assigned projects, quality control development of new products, monitoring trends in the cosmetic field and writing reports on work done and in progress. He is familiar with research and development issues in higher education institutions.

MRS NOMAHLUBI SHEZI holds a B.Sc. Eng (Chem.), Massachusetts Institute of Technology, USA and a B. Eng (Hons) (Management of Technology) from the University of Pretoria. She is currently a part-time student in M. Eng (Technology Management) at the University of Pretoria.

Previously, she was a senior process engineer at Sasol and was responsible for concept development of new projects for the chemical business units (2001-2004). In 2004 was responsible for the power generation study within the coal-to-liquids (ctl) project in China and USA. This project was at the pre-feasibility stage therefore she was evaluating technical and economic feasibility of power production. Between Jan 1999 and Dec 1999 she was a Business Analyst for SHELL SOUTHERN AFRICA, LTD, Cape Town. She was responsible for evaluating Sapref's capital project proposals by understanding project focus, cost vs. benefit and viability.

She is currently involved in technical evaluation of projects for the Support Programme for Industrial Innovation for the IDC. In addition to that, she is participating in a project that involves the survey of R&D expenditure in Health in South Africa for the Department of Health.

DR FRANK Teng Zeng

Frank Teng-Zeng obtained his doctoral degree in Political Science from University of Stellenbosch, South Africa in 2002. He also holds a Masters degree in International Studies from the same University awarded in 1999, and completed his undergraduate studies (BA Honours degree) in Sociology at the University of Ghana, Lagon in 1996. His dissertation at the doctoral level is entitled “Transnational Science and Technology Co-operation in Africa: An Evaluation of Selected Institutions and Programmes”.

He has work on projects including: “Capacity-Building in the Development and Transfer of Technologies”, Commissioned by Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC), Bonn Germany in 2003; “Optimising the Role of Science and Technology in Sustainable Development within the Context of NEPAD (commissioned by South African National Advisory Council on Innovation (NACI) in 2003 and 2005); and the Africa PRIME Network Project- Research on National Innovation Systems in Developing Countries 2005. He was involved in SARIMA-Research Africa Project supported by DFID, UK; Researching Inequality through Science an Technology (ResIST) funded the by European Commission (with initial support from DST, South Africa) by looking at Scientific Mobility and the African Diaspora; Twenty-two African Countries Science and Technology Profiles commissioned by DST, South Africa in 2006; and The Africa Science & Technology Indicators and Mapping Project- an initiative of CREST and CWTS at Leiden University.

Teng-Zeng has published and presented papers at international and national conferences including an invitation to present at the Science Forum of the World Summit on Sustainable Development (WSSD) held in the Republic of South Africa in August 2002; the New Partnership for Africa's Development (NEPAD) Conference *Conditions for Maximising S&T to NEPAD Process*, organized by South Africa's National Advisory Council on Innovation (NACI), Eskom Convention Centre, Midrand, South Africa, in October 2002; and invited discussant on Regional Profile on Sub-Saharan Africa- *Symposium on Comparative Analysis on National Research Systems*, organised by UNESCO Forum on Higher Education, Research and Knowledge, UNESCO Head Office, Paris, France in January 2008.

His current research interests include National Innovation Systems focusing on S&T human resource development and research at Higher Education Institutions, financing R&D, tax incentive and technological innovation issues; Science, technology and development; Research and transfer of environmentally sound technologies; Science, technology and foreign policy; Multilateral and bilateral institutions in the development of S&T in Africa.

He is working with High Impact Innovation on Regional Innovation Systems Case Study in the Eastern Cape Province in South Africa and independently looking at scientific mobility and National Innovation System Competitiveness in South Africa and African Higher Education Research and Postgraduate Training Network mapping project as well as Science, Technology and Innovation Indicators Development in Africa.

SERVICES RENDERED TO CLIENTS

Support Programme for Industrial Innovation (IDC)

Appointed by the IDC in 2003 as a consultant to conduct technical and commercial due diligence (ongoing)

National Department of Agriculture

Assisted the Department of Agriculture in the development of a national Agricultural biotechnology strategy in March 2004

Highveld Biological, a biotechnology company

Employed by this biotechnology company to develop its business development strategy and redefine its R&D activities.

Innovation Fund, NRF

Appointed by the Innovation Fund as a business and technical evaluator of Project proposals in 2003 (ongoing)

Softstart Incubator (part of consortium)

As part of a joint venture, conducted a market survey to identify and profile companies and individuals who are potential clients for the ICT incubator (completed)

Ntsika, DTI

Conducted an assessment of the Technology Stations at the technikons as possible intermediary service providers of technological support to SMMEs (February 2004)

Department of Science and Technology

Appointed to conduct a study to develop S&T profiles of countries with Bilateral and Multilateral Co-operation with South Africa (ongoing)

Department of Agriculture

Appointed by the Directorate of Planning, Evaluation and Communication to facilitate a Strategic alignment and team building workshop. (August 2004)

Agricultural Research Council

Evaluation of Sustainable Rural Livelihoods Programme (Sept 2005-Feb 2006)

BioPAD

Development of an **international** technology transfer strategy in biotechnology (2005, completed)

National Department of Agriculture

Development of Biotechnology Roadmap for Agricultural Biotechnology (May 2006-Nov 2006)

Department of Health

Survey of R&D Expenditure in Health Research (July 2006-October 2007)

Department of Science and Technology

Development of S&T profiles of selected African countries in partnership with CREST, University of Stellenbosch (May 2006-August 2007)

National Research Foundation and Higher Education of South Africa (HESA) –Evaluation of

Management Processes of the Evaluation Process of Researchers (June -August 2007)

Department of Science and Technology

Survey of Bilateral Cooperation in Science and Technology, in progress

Eastern Cape Socio-Economic Consultative Council

Development of R&D and Innovation Strategy