

# THE REPUBLIC OF BOTSWANA

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## Introduction

This report looks at the science, technology innovation system of the Republic of Botswana and is structured in three main sections. Section 1 briefly deals with the national political environment; Section 2 looks at the country characteristics including the economic, demographic and health, education, and information and communication technology infrastructure. Finally, Section 3, which forms the main part of the report, gives an overview analysis of the science and technology system. This section is subdivided into thematic subsections covering governance of the science and technology, science and technology landscape, S&T human resources, funding, research outputs, technological innovation and lastly international co-operation and networks activities.



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## Section 1: The political environment

Botswana is a landlocked country in Southern Africa that gained political independence from the British Colonial Protectorate administration on the 30<sup>th</sup> of September 1966.<sup>1</sup> It has a total land surface of 582 000 square kilometres. The countries bordering it include- Zambia and Zimbabwe to the northeast, Namibia to the north and west, and South Africa to the south and southeast. While at Kazungula, four countries - Botswana, Zimbabwe, Zambia and Namibia - meet at a single point mid-stream in the Zambezi River (see Figure 1). The country has three land tenure systems namely the tribal or communal land (74%), state land (23%) and freehold land constituting 4%.

Since independence, a constitutional and democratic system of governance has characterised the body politic in the country. Three successive and peaceful changes of governments have occurred through national elections since independence. In fact, former President Quett Masire voluntarily resigned in March 1998 and allowed then Vice President Festus Magoe to succeed as president before he was officially elected in October 1999. Although the same political party, the Botswana Democratic Party (BDP), has ruled the country since independence and the process of presidential succession in the party has sometimes been described as elitist, political stability and the fight against institutional corruption in the country still remains the envy of most countries striving for democracy and economic development on the continent.

<sup>1</sup> Britain declared a protectorate over Bechuanaland (now Botswana) in 1885 and the present day borders of the country remained the same.

## Section 2: Country characteristics

### 2.1 Basic economic outlook

Botswana is one of few countries in Sub-Saharan Africa ranked as an upper middle-income country. Botswana's national currency, the Pula (P), is one of the strongest on the African continent, although the currency was devalued by 7.5% in February 2004. Despite its strong economy, it is still relatively small in comparison to the current ten largest economies in Africa. The real gross domestic product GDP economic growth rate averaged 5.4% from 2000-2003 but decreased to 4.4% in 2004 before rising to 8.3% in 2005. The GDP per capita increased to US\$4,816 from an average of US\$3,496 in the period of 2000-2003 (AfDB, 2005:86)<sup>2</sup>, but a third of its population lives on less than a dollar a day (UNFPA & PRB, 2005).<sup>3</sup> To encourage investment the government abolished foreign exchange controls in 1999. Nevertheless, foreign exchange transactions forms must still be completed, as the Bank of Botswana requires a record to keep track of the amount of currency in circulation (GOB, 2006).

The overall national economy is dominated by mining and agricultural sectors activities. However, the contribution of agriculture to the national GDP decreased from 40% at independence to 4% in 1996 and to 2.4% in 2002/03 and 2.3% in 2003/04 financial years (GoB, 1998:8; Gaolathe 2005), Botswana is the world's largest exporter of diamonds. Revenues from diamonds constitutes 80% of the country's exports and 35% of its GDP (with 50% for mining as whole), but garment sales have increased under the US trade agreement with Africa known as AGOA (Africa Growth and Opportunity Act) (AfDB, 2004:91).<sup>4</sup> For example, textiles and apparel exports increased six-fold from P37.6 million in 2003 to about P225.5 million in 2004, mainly because of expansion of existing and extension of least developed country beneficiary status to Botswana (Gaolathe, 2005)<sup>5</sup>. In 2003, the government launched the ninth National development Plan for 2003/04-2008/09. As part of this national development strategy, the government has intensified efforts to diversify the economy by expanding non-mining sectors. The government considers science, technology and innovation capacity development as a major driver to diversify the economy and the country's move towards a knowledge-based economy and competitiveness (see Section 3 below).

In terms of general economic competitiveness, there was little comparative data for most African economies because the early issues of the *Global Competitiveness Report* covered few countries in Africa until the publication of *The Africa Competitiveness Report* by the World Economic Forum in 1998. The early edition of *The Africa Competitiveness Report* became "the first systematic benchmarking exercise for combining broad macroeconomic and political analysis of firm and country"(WEF, 2000) for 24 African countries.<sup>6</sup> The third Africa Competitiveness Report, which covered 25 countries, was published in 2004. This report highlights the prospects for economic growth, obstacles to improving competitiveness, and the need to accelerate the pace of economic change in the 25 selected African economies. The report uses the *Global Competitiveness Index* (GCI) which has three sub-indices including the public institutions index; macroeconomic environment index and technology index. Overall Botswana is ranked the first as the most competitive economy among 25 countries ahead of Tunisia and South Africa in second and third positions respectively. This means that Botswana has improved its position in the ranking by moving from the third spot in the previous two issues. In the three sub-indices, except for the technology index where South Africa (1), Mauritius (2) and Tunisia (3) and Botswana 4th, the country is ranked first in the other two sub-indices. In the 2005 GCI rankings, Botswana is 48<sup>th</sup> behind South Africa's (42<sup>nd</sup>) out of 117 economies. Table 1

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<sup>2</sup> At independence in 1966, Botswana had national per capita income estimated at P60 (about the equivalent of US\$80).

<sup>3</sup> According to the Botswana 2002/2003 Household Income and Expenditure Survey 2002/03 income inequality as represented by the GINI Coefficient, increased significantly in urban villages and rural area households between 1993/94 and 2002/03 with an estimated 36% of the rural population and 23% of the total population living below the poverty line of US\$1 per day. The explanation given for this trend is increasing unemployment amongst 15-19, 20-24 and 25-29 years olds (Intelecon, 2006).

<sup>4</sup> Despite the significance of the mining sector to export earnings and accounting 35% of GDP, it only accounts for about 3% of total formal national employment (Berndsen, 2006).

<sup>5</sup> Unless extended Botswana will not enjoy the least developed country status under AGOA after 2007.

<sup>6</sup> Note that until the Global Competitiveness Report in 2004, there were few countries in Africa covered by the previous issues. It was in the 2003-2004 Global Competitiveness Report that the number of African countries increased from 8 to 25. In this report 22 new countries (of which seventeen of in Africa) were added in the coverage, while the total number of countries increased from 80 to 102.

provides a list of selected economic indicators while Table 2 shows the country's competitiveness ranking in Africa in 2004.

Table 1: Botswana Selected Basic Economic Data

Category	1997	1998	1999	2000	2001	2002	2003	2004	2005
Gross domestic product, real (US \$ million, constant 2000 prices)	4365	4628	4878	5251	5526	5771	6084		
Gross domestic product Growth Rate (%)	6.9	6.0	5.4	7.6	5.2	4.4	5.4	4.4	
Net aid from all donors, Real (US\$ millions, constant 2002 prices)	122	106	61	31	29	38	30		
Net aid from all donors as share of recipient GDP (%)	2.3	2.2	1.2	0.6	0.6	0.7	0.4		
National Inflation Rate (%)							4.7	7	8.6

Sources: Own compilation from World Bank WDI

Table 2: Changes in Botswana Competitiveness Ranking in Africa, 2004

Country	2004 Rank (out of 25)	2004 Score	2000 Rank (out of 24)	Rank changes 2000-2004
<b>Botswana</b>	<b>1</b>	<b>4.56</b>	<b>3</b>	<b>+2</b>
Tunisia	2	4.49	1	-1
South Africa	3	4.37	7	+4
Mauritius	4	4.12	2	-2
Namibia	5	3.99	4	-1
Gambia	6	3.93	n/a	n/a
Egypt	7	3.84	6	-1
Morocco	8	3.77	5	-3
Tanzania	9	3.49	14	+5
Ghana	10	3.46	9	-1

Source: Own compilation from WEF Africa Competitiveness Reports 2000 and 2004.

## 2.2 Demographic characteristics

The total population for Botswana is estimated at between 1.6 million and 1.8 million since the last national census in 2001 (Central Statistics Office, 2001). The annual population growth

between 1994 and 2003 is estimated to average 2.1%, which is much lower than the previous decade. However, the impact of the HIV/AIDS pandemic on the population is considered a serious developmental challenge. The HIV/AIDS prevalence rate in Botswana is one of the highest in the world - with about 37 percent of the 15-49 age group estimated to be HIV positive. This process has stalled development and reversed health gains (UNFPA & PRB 2005).<sup>7</sup> For example, a recent report indicates that life expectancy has decreased from 65 years in 1990 to 35 years in 2005 although the infant mortality rate has remained steadily at 47 deaths per 1000 live births (UNFPA & PRB 2005).

Because of the impact of HIV/AIDS on national development and socioeconomic transformation, the pandemic has been described as an area of national development priority. If unchecked and stabilized the spread and rate of infections, HIV/AIDS will have serious negative impact on the country's future human resource capacity development, economic growth and competitiveness. Already some studies have showed that the high incidence of HIV/AIDS has combined with other factors in the world economy (e.g. high oil prices and a weak US dollar) to slow down the growth in the manufacturing and agricultural sectors, impacting negatively on general economic activity (AfDB, 2004; 2005). The government approved the National Population Policy Plan of Action for 1998-2008 to address a number key health and gender related issues in the country (UNFPA & PRB 2005). Table 3 shows some characteristics of the population in the country.

**Table 3: Botswana Selected Demographic Characteristics**

Indicator	Source Year	Estimate	Sources for the Estimation
<b>Demographic data</b>			
Total population (thousands)	2001	1,680,863	Central Statistics Office (CSO), Gaborone
Population aged 15-49 (thousands) %	2001	52.0	CSO, Gaborone
Annual population growth (%)	2001	2.4	CSO, Gaborone
Percentage of urban population	2001	54.2	CSO, Gaborone
Crude birth rate (per 1,000 population)	2001	28.9	CSO, Gaborone
Life expectancy at birth (years)	2001	55.6	CSO, Gaborone
Total fertility rate	2001	3.27	CSO, Gaborone
Infant mortality rate (per 1000 live births)	2001	56	CSO, Gaborone
Adults aged 15-49 with HIV/AIDS (%) <sup>8</sup>	2001	38.0	US Population Reference Bureau

<sup>7</sup> A recent CSO report Botswana AIDS Impact Survey II based a representative sample of the whole population and provides a comprehensive picture than previous studies indicates that the incidence of the disease among those aged 18 months of age and older is 17.3%, while the incidence for the those aged 15-49 years is 25.3% (Gaolathe 2005 budget speech).

<sup>8</sup> Based on CSO Botswana AIDS Impact Survey II in 2004, the incidence for population aged between 15 and 49 years is 25.3, considerably less than previous figures (Gaolathe, 2005).

### 2.3 Health resources

The Public Health System is critical to any economic development processes as has been highlighted in recent reports of the World Health Organisation (2005 & 2006). In Botswana, the impact of the HIV/AIDS pandemic makes improving the health facilities and the human resource base for both treatment and research a national development priority. Available data shows that the Botswana Public Health System consists of different kinds of national health facilities which include 23 district health teams, 3 referral hospitals (Princess Marina in Gaborone, Nyangabwe Hospital in Francistown and Lobatse Mental Hospital); the others facilities in 12 district hospitals, 17 primary hospitals, 222 clinics, 330 health post and 740 mobile stops. Overall, the Botswana Health Professional Council (BHPC) is responsible for the development of strategies, policies, guidelines and standards for the registration of 25 professions and consists of 19 members. The BHPC also has committees, which assist and facilitate the performance of the Council and fulfils its mandate in accordance with the Botswana Health Professions Act, 2001 (MoH, website April 2006). In 2005, the government announced that it was undertaking a number of infrastructural developments in the country including the construction of Institutes of Health Sciences facilities at Molepolole and Serovwe and the upgrading of district and primary hospitals to improve health services (Gaolathe, 2005). Table 4 lists the number of selected health personnel in the period from 1997 to 2001.

**Table 4: Botswana Selected Health Personnel, 1997 – 2001**

Number of Personnel	1997	1998	1999	2000	2001
Doctors	461	424	507	499	548
Nurses	4,130	4,265	4,265	4,319	3,994
FWEs	749	742	742	1,269	821
<b>Per 10000 population</b>					
Doctors	3.0	2.7	3.1	3.0	3.3
Nurses	26.5	27.1	31.0	26.2	23.8
FWEs	4.9	4.7	4.8	47.6	4.8

Source: Compiled from CSO, Gaborone accessed on 7 June 2006.

### 2.4 Education

Education at all levels is receiving government's attention beginning with the expansion at the basic level in 1960s. This was followed by the creation of the first Secondary Education Department in 1973 to promote and manage secondary education in the country. It invests heavily in the provision of secondary education due to increasing demand. Today there are two hundred and five (205) Junior Community secondary Schools and twenty-seven (27) Senior Schools. The country achieved 100% access to primary education in 2000, with the transition from primary to junior about 100%. The challenge at present is the transition rate from junior schools to senior schools that stands at 50.8%, a small increase from the 49.1% of 2001. With the expectation and prospect of building more schools and upgrading others, the government hopes to achieve its objective of universal secondary education by increasing access (MoE website, accessed 12 July 2006). Already the transition rate from junior to senior secondary schools has improved for 2006 at 61.03% involving 23086 admitted candidates from a pool of 37828 candidates who were examined (MoE, 2006). Access to tertiary education is also increasing and there are plans to expand higher education infrastructure including the establishment of a second University in addition to the University of Botswana.

In terms of general adult population literacy, Botswana carried out its first national household survey on literacy in 1993, followed by a second one in 2003. The 2003 Literacy survey results indicated a National Adults Literacy Rate of 81% among population 15 years and over. This represents an increase of 12% from the 68.9 % in 1993. The gender desegregation showed female adult literacy rate of 82% compared to 80% for males (CSO, 2006).

## 2.5 ICT infrastructure

In 2001, the World Economic Forum (WEF) launched its first Global Information Technology *Report*. According to the WEF, this Report "has become a valuable and unique benchmarking tool to determine national ICT strengths and weaknesses and to evaluate progress". It also highlights the continuing importance of information and communications technology (ICT) application and development for economic growth. The Report uses the *Networked Readiness Index* (NRI), covering 115 economies in 2005-2006, to measure the degree of preparation of a nation or community to participate in and benefit from ICT developments. The NRI is composed of three component indexes that assess:

- the environment for ICT offered by a given country or community
- the readiness of the community's key stakeholders - individuals, business and governments
- and the usage of ICT among these stakeholders

During the preparation of the Botswana Draft National Information and Communications Technology Policy, an ICT market survey was conducted to support the e-Readiness Assessment in 2004. The survey results indicated that annual ICT expenditure in Botswana was estimated at P1 billion. Of this amount, about P250 million per annum comes from the government sector, while about P750 billion per annum comes from other sectors (MCST, 2005:10). The expenditure on telecommunications in Botswana is estimated at 4% of GDP in 2005 (Intelecon, 2006).

The increase in investment from the private sector follows the adoption of the Telecommunications Policy for Botswana, which introduced partial competition in the telecommunications sector in 1995, followed by the enactment of the Telecommunication Act of 1996. Prior to that Botswana Telecommunication Corporation (BTC) had a monopoly and mandate to provide all telecommunications services to all areas in the country. The implementation of the Telecommunications Act led to the establishment of Botswana Telecommunications Authority (BTA). The partial liberalization promoted foreign direct investment (FDI) in two cellular joint venture consortiums - Mascom Wireless Botswana and Orange Botswana as well as citizen ownership and participation in the ICT sector (Venson, 2006).

In fact, Botswana's fixed line teledensity was only 3%, with no mobile telephony in 1996. However, Botswana fixed line network subscription numbers stood at 135128 as at 31 August 2004, with teledensity of 8%. During the same period combined Mobile subscriptions increased from zero to 541672 or 32% of teledensity. In addition, in August 2004 there were other licensed operators including 18 Internet Service Providers, 10 Private Networks and 10 data Network Service Providers, 5 International and national Data Gateways, 2 Commercial Radio Stations and a commercial Television Station (Lekaukau, 2004). There seems to be a growing shift towards mobile telephony with the BTA Annual Report 2006 showing that the fixed telephone service provided by BTC experienced a decline of 4389 subscribers between March 2005 and March 2006. The number of subscribers fell from 136423 to 132034, while the mobile phone market - provided by Mascom and Orange - experienced a growth from 577437 subscribers to 823070 in the same period (BTA, 2006). The coverage by mobile phone has reached 80% of Botswana's population of 1.7 million people. Together about 85-90% of the population have access to fixed and/ or mobile telephony services, but

considerable fewer have access to dial-up or broadband Internet and data services while the government is aiming for universal access of 96% (Intelecon, 2006).

Based on WEF reports Botswana is ranked in the 56th position out of 115 countries in the 2005-2006 ICT report making the country one of the highest African countries covered after Tunisia (36) and South Africa (37). Table 5 below shows the technology profile relating to ICTs. Meanwhile as part of the ongoing telecommunications infrastructure upgrading, Botswana has established cable links with South Africa and Zimbabwe. Another cable link project is planned to link Botswana and Namibia, with possible extension to Angola. According to the government, the completion of the future link projects will complete the telecommunications network backbone of the country. This will also place the country within the context of regional ICT Hub in SADC and to make the country's ICT sector globally competitive as envisioned in the Botswana 2004 National ICT Policy, 'Maitlamo' (Gaolathe, 2005).

**Table 5: Botswana Selected ICT Indicators**

<b>Growth Competitiveness Index (Technology)</b>	<b>Rank out of 25 African countries</b>	<b>Rank out of 102 countries</b>
Quality of competition in the ISP sector	20	93
Internet access in schools	8	76
Laws relating to ICT	12	73
Internet users, 2002	5	72
Telephone lines, 2002	5	68
Internet hosts, 2002	4	63
Personal computers, 2002	5	59
Cellular phones, 2002	3	51
Government prioritisation of ICT	9	36

Source: WEF, Global Competitiveness Report 2003-2004.

On the 21<sup>st</sup> of June 2006, Ponomi Venson, the Minister for Communications, S&T announced the further liberalisation of the telecommunications sector in order to increase competition with enhanced quality of services at reduced cost. She also announced that the government has taken a decision to privatise BTC and to sell off a portion of about 40% of the equity to a strategic equity partner. In addition, the government decided to allocate a small portion of shares of 5% to citizen employees of BTC; to place another portion of shares in a privatization trust fund (15-25%) for sale to future generations of Botswana; and to retain 25- 30% of the shares for later sale to the public through stock market listing (Venson, 2006).

### **Section 3: Science and Technology system<sup>9</sup>**

The significance of the potentials of Science and Technology (S&T) for social transformation and economic development cannot be over emphasized. S&T provides a vehicle for translating natural resources into value added, quality goods and services, towards achieving the developmental goals of

<sup>9</sup> Introduction from SCOPE 2015 Project.

a nation (UNDP, 2005). Crucial to the socio-economic development of a nation is the effective use of technology, and those countries which have put the most energy, initiative and money into technology have reaped the benefits of greater social and economic development, resulting in improved living standards for their citizens. Hence, worldwide, governments in partnership with stakeholders, seek ways to harness these potentials by putting in place appropriate S&T policies and institutional frameworks.

Stressing the significance of S&T led development in Botswana, the immediate past President of Botswana, HE Quett Masire recently observed: "We cannot survive the ruthless competitive world of today without harvesting science and technology. Only science and technology led development will give us a chance to become serious players in the international market place" (quoted in UNDP, 2005). The current Minister of Communications, S&T, in her recent launching of the UNDP Botswana Human Development Report 2005 (UNDP 2005), acknowledged that S&T has played an important part in economic diversification, poverty alleviation, sustainability of the natural resources and the environment. She therefore urged for the active promotion of S&T as part of a development process. With this realisation at the highest level of governance in the country, over the years, the Government of Botswana (GoB) has been making efforts directed at facilitating advances in S&T by setting up appropriate institutional frameworks and policy mechanisms. These include the setting up of research centres, enactment of an S&T policy and creation of a Ministry for S&T, as well as funding support for Research, S&T and Innovation (RSTI) activities. The recent decision to set up a second university with an S&T focus saw these efforts taken to a higher level of commitment to accelerate sustainable S&T led socio-economic development in the country.

There are critical developmental issues recurring in the National Development Plans (NDPs) which are particularly appropriate to the task of harnessing the S&T potentials [Milne et al, 2000]. These include health and food security, human resources development, knowledge generation, conservation and sustainable use of natural resources and environment, diffusion of appropriate technology to promote domestic production and job creation, poverty alleviation and sustainable economic growth and diversification. According to a media report [Chwaane, 2005], the Minister of Communications, Science and Technology recently stated, "Botswana still lacks the science and technology environment conducive for the level of technology diffusion and transfer necessary for the country's next phase of development. This is coupled with the need for adequate human resources" she was quoted as saying. She identified the challenges Botswana faces in productive S&T activities to include inadequate scientific infrastructure, research bodies, co-ordination, integration and management as well as implementation constraints [Chwaane, 2005]. In writing the Foreword to the Botswana National Development Plan 9 [GoB-NDP9, 2003], HE the President identified key challenges facing the country as including economic diversification, rural development; disaster management, environment protection, human resource development, macroeconomic stability and financial discipline, and development of S&T. The ongoing concerted efforts to implement the national S&T policy by putting necessary institutional framework and national Research, S&T Plan (RSTP) in place are aimed at creating a conducive environment to address these challenges through harnessing the S&T potentials.

### 3.1 *Governance of science and technology*

The institutional origins of S&T in Botswana can be traced back to the establishment of the first experimental agricultural station at Mahalapye and Morale in the 1930s. The establishment of a Department for Agricultural Research in 1961 and of the National Veterinary Laboratory in 1968 shows how concerns related to agricultural research dominated the early years of S&T in the country (Beintema et al 2004). A significant step towards the broadening of research and training in the country was taken with the establishment of the University of Botswana as a national university in 1982.

#### 3.1.1 *Ministry of Communications, Science and Technology (MCST)*

Until the establishment of the Ministry of Communications, Science and Technology (MCST) in 2002, there was no government department or ministry with direct responsibility for science and technology. In 2004, the Department of Research Science and Technology (DRST)

was established under the MCST and its first Director was appointed in June 2004 followed by the appointments of other key staff. The Government of Botswana created the ministry “primarily to turn Botswana into an information and knowledge-based economy”. The Ministry would achieve this goal by formulating relevant ICT and Science and Research policies as well as coordinating their implementation through national, regional and global collaborative efforts that harness local resources, talent and innovation” (<http://www.mcst.gov.bw>, accessed 11 July 2006). MCST now has the responsibility for the management of the science system including the three technology and scientific research institutions: The Botswana Technology Centre (BOTECH), the Rural Industries Promotions Company (Botswana) (RIPCO(B) and its subsidiary - the Rural Industries Innovation Centre (RIIC), and the National Food Technology Research Centre (NFTRC).

According to DRST, one of the first key responsibilities was to define what research products and services the ministry is actually funding and why it is funding them. Another responsibility was to create a planning and reporting system for the research institutions that reassures government that institutions will be scientifically and financially viable in the long term (<http://www.mcst.gov.bw>, accessed 11 July 2006).

In terms of policy formulation, prior to the establishment of MCST the Government of Botswana (GoB) took general responsibility to draft the first Botswana National S&T Policy (BNSTP) which was approved by the Parliament in 1998 (GoB, 1998). The responsibility for this policy development process was delegated to BOTECH. The Department of Research, S&T under this Ministry now takes responsibility for the implementation of the policy as well as the development of new strategies to enhance the science and innovation system in the country. For example, the new ministry completed a draft ICT Policy in 2004 and commissioned a study to formulate the Botswana Research, Science and Technology Plan in 2005. This plan is part of the strategy towards the implementation of S&T policy and other development priorities requiring the application of S&T including the Botswana Vision 2016 and the National Development Plan 9 (NDP9 9). In June 2006, the MCST also published the draft rural telecommunications strategy. The strategy aims at further bringing rural communities into the mainstream of society and provide telecommunications infrastructure for potential economic activity outside the major population centres (<http://www.mcst.gov.bw>).

The other government department that has a major commitment to S&T (also historically) is the Department of Agriculture. We discuss their involvement in S&T separately.

### 3.1.2 *Ministry of Agriculture*

As indicated above, prior to independence, public agricultural research in Botswana began in the 1930s with the establishment of an experimental station that focused on a variety of crops, and livestock research conducted at a ranch under the Department of Agricultural Research (DAR). Following independence, the Department of Research and Development under the Ministry of Agriculture became the main research unit for agricultural research excluding the university of Botswana and Botswana college of Agriculture.

The DRD has three main divisions:

- The Animal Production and Range Research Division (APRRD) that undertakes research, development and technology transfer to the benefit of the livestock industry in Botswana. The Division conducts research mainly on development and improvement of cattle, sheep, goats, range and pasture. There are five programs namely Beef, Dairy, Small stock, Feeds and Range and Pastures.
- The Arable Crop division has a mandate to conduct research on crops of importance to the farming system of Botswana as well as those with potential for diversifying the production base. The focus is on agronomic and breeding aspects and all the other components that provide a holistic approach to production. The division operates through six commodity-based programmes. These programmes include Soil, Water Management and Engineering Programme; Oilseeds Improvement Programme; Grain Legume Improvement Programme; Horticultural Improvement Programme; Production Systems Programme and Cereal Improvement Research Programme.
- The Support Services Division has the mandate to provide its internal and external stakeholders with research support services from its units and sections under Department Management (Human Resources Development, Budget & Accounts, Records management, Supplies, Transport and Messenger Services); Estate Management (Farm Management, Operations Management, Security Services and Development Projects); Laboratory Services (Plant and Soil Analyses ) and Information and Communication Technology (Biometrics, Computing Services, Information & Publicity Office and Library). Other responsibilities include management of regional agricultural research stations, and the implementation of government reforms that are Performance Management System (PMS), Work Improvement Teams (WITS), and HIV/AIDS.

On 31<sup>st</sup> October 2002, the Ministry of Agriculture launched the National Master Plan in Arable Agriculture and Dairy Development (NAMPAADD). The plan will be implemented over a period of ten (10) years. The first three years of implementation will include the establishment of pilot projects in areas of high production potential designated as priority areas in the Master plan). It is expected that the NAMPAADD will make arable and dairy farming profitable and more attractive to farmers, thereby creating employment opportunities, increase rural incomes and reduce rural to urban migration. It is also expected to succeed in transforming the agricultural sector because it commences at a time when public sector reforms that include quantifying performance objectives with measurable targets are being put in place to improve performance and accountability across the sector (GOB [http://www.gov.bw/government/ministry\\_of\\_agriculture.html#agricultural\\_planning\\_and\\_statistics](http://www.gov.bw/government/ministry_of_agriculture.html#agricultural_planning_and_statistics)).

In 2004, Botswana held its first National Consultative Workshop on Biosafety as part of the process of developing a National Biosafety Framework (NBF). The process led to the publication of a new National Biosafety framework in February 2006. The document contains three sections: *Section 1*, which provides an overview of the background that went into developing the National Biosafety Framework (NBF) for Botswana. *Section 2* is the Biosafety and Biotechnology Policy for Botswana. *Section 3* covers the consultant's Draft Bill. The Policy articulates the position of Botswana regarding the different areas that by biotechnology or biosafety activities can influence, and these include the areas of agriculture, commerce and industry, education, environment, health and ethics (see NBF, 2006).

In December 2005 the Botswana National Research, Science and Technology Plan (BNRSTP) was published.<sup>10</sup> The plan identifies priority areas of research across several sectors including health, the service industry, eco and cultural tourism, the software, manufacturing, mining; energy; agriculture; media education and human resources development; housing and construction as well as transport and logistics. These priority research fields are further grouped into three main research platforms including Mission-focused Programmes; Centres of Excellence and Line Research. These research priority areas are consistent with the national and sectoral policies listed above.<sup>11</sup>

The Mission-focused platform programme identified five priority programmes that deal with: the ecosystem; manufacturing, engineering infrastructure; processing and mining; geomatics; and Biosciences.

According to the BNRSTP, investment in Mission-focused programmes will encourage inter-institutional cooperation, promote multi-institutional collaboration by leveraging the relative strengths of participating institutions, provide for a comprehensive problem solving approach by bringing together the right expertise for each stage of R&D process, and provide a critical mass of researchers (BNRSTP, 2005:9)

The Centres of Excellence platform programme identified five areas of research priority:

- energy for the future;
- infectious diseases;
- indigenous knowledge and technology systems;
- information and communications technology; and
- human sciences and policy research (BNRSTP, 2005:9).

Within the Line Research platform programmes, the BNRSTP identifies seven research fields which are considered relevant to six ministries including the Ministries of Agriculture, Minerals, Energy and Water Resources; Wildlife, Environment and Tourism; Health; Communications, as well as Science and Technology. These research fields include agricultural research; minerals research; water research; research to support environmental management; health research; communications research and energy research (BNRSTP, 2005:15-17).

### 3.2 *Science and technology landscape*

In March 2001 Baledzi Gaolathe, Minister for Finance and Development Planning announced that, the government will soon start the implementation of the science and technology policy of Botswana, during the presentation of the Ministry's budget in Parliament. Gaolathe said the process would start with the establishment of a national commission on science and technology. He indicated that the commission would be the supreme policy advisory body to government. It would advise government on priorities in science and technology, including financing, as well as ways of forging smart partnership between government, the business sector and the scientific community. Following the establishment of the commission, the Botswana research, science and technology investment agency

<sup>10</sup> This Plan was prepared by consultants from the Council for Scientific and Industrial Research (CSIR) group based in Stellenbosch, South Africa in partnership with two groups Performance Resources (Botswana) and Mahayana and Associates (Botswana) for the Ministry of Communications, Science and Technology, Botswana.

<sup>11</sup> For example the key areas identified in the 1998 BNSTP include: Agriculture, Forestry and Fisheries; Commerce and industry; Education and human resource development; Energy; Environment; Health; Meteorology; Mining; Population planning and human settlement; Tourism; Transport and communication; Water, and wildlife. IPRs; Safety and Quality Standards; Financing: S&T Information and Information Technology; S&T Co-operation; Gender; Technology Assessment; Acquisition; Monitoring and Forecasting; Management of S&T; Social Science. Research; Media

would be formed with the primary function of coordinating all funding and investment for science and technology research and development. Gaolathe said some of the agency's major functions would include development of research strategies for joint ventures and partnerships among research providers, monitoring and evaluation of projects undertaken.

### 3.2.1 S&T Agencies

Beside the line government departments and ministries with direct or indirect responsibility in the governance of science and innovation system, there are a number of agencies whose activities support research activities in Botswana. However, most of these agencies have only recently been established as shown in Table 6 below.

**Table 6: Summary of key S&T Agencies and functions**

Agency	Established	Function
National Commission for S&T (NCST)	May 2002	S&T research Policy advisory matters
Botswana Research, S&T Investment Agency (BRSTIA)	2006/07	Co-ordinate and monitor all government R&D funding (S&T research Purchasing matters)
Government owned National Centres for research	See different research institutes	S&T research Provision matters
Botswana National Association of Scientists and Technologists (BNAST)		Policy Advocacy matters
Tertiary Education Council (TEC)	March 1999	Higher education policy development , institutional guidelines and support

#### 3.2.1.1 National Commission for Science and Technology (NCST)

An eleven-member National Commission for Science and Technology (NCST) was established on the 16<sup>th</sup> of May 2002. The commission's mandate included the provision of policy guidelines, financing as well as forging "smart partnerships between government, business sector and scientific research communities".

The NCST launch was regarded as an important milestone in government endeavours towards the implementation of the Science and Technology Policy for Botswana approved by Parliament in July 1998. One of the reasons for formulating the policy was the urgent need to co-ordinate and integrate science and technology, research and development activities in the national development planning process. "Even before the formulation of the policy, government had already recognised the potential for science and technology, research and development to facilitate industrial diversification and enhanced productivity for greater economic growth and development." In this regard, government had established a number of public-funded organisations, such as the Department of Agricultural Research, Botswana Technology Centre (BTC) and Rural Industries Promotion Company (RIPC) but still mechanisms for co-ordination and integration were inadequate.

### 3.2.1.2 *Tertiary Education Council (TEC)*

The origins of the Tertiary Education Council (TEC) lie in the report of the national commission on education in 1993 that recommended that such a body be established. These recommendations were endorsed by the government in the revised national policy on education, passed by parliament in 1994. In March 1999, tertiary education legislation was enacted to bring the TEC into being. Act of 1999 gave statutory backing to the creation of TEC as a body corporate enjoying autonomous status. However, the Council began its work with the appointment of the Council Members in June 2002 and the employment of the Dr Patrick Molutsi as its first Executive Secretary on the 1st of October 2003.<sup>12</sup> It is governed by a 14 (fourteen) member Tertiary Education Council. The TEC is a regulatory body to coordinate and promote tertiary education in Botswana. The TEC Secretariat is organised around 5 (five) directorates namely the Office of the Executive Secretary, the Directorates of Budgeting and Funding, Corporate Services, Policy Planning and Research as well as Quality Assurance and Regulation. The mission of the TEC is to plan, develop and coordinate a well-resourced and comprehensive tertiary education system, contributing to Botswana becoming a knowledge-based society.

The Council from time to time commissions research on tertiary education or human resources development related issues as a way of better informing itself and advising government and other stakeholders. The Council commissioned a working Group to help formulate a draft Tertiary Education Policy for Botswana in 2004 and it is currently undertaking a study of the graduate labour market and there are plans to develop national human resources development strategy for Botswana by 2009.

## 3.2.2 *R& D Performing Institutes*

The R&D performing institutions in Botswana may be categorized into the higher education sector institutions, public sector research and technology institutes as well as private sector research institutes. However, the private sector still performs limited research. The discussion below deals with the first two sectors only.

### 3.2.2.1 *Higher Education Sector*

The importance of the higher education sector in developing human resource and undertaking research for socio-economic development cannot be underestimated in any country. Today the University of Botswana and its affiliated institutions are the main centres for undertaking scientific research and the training of present and future generation of researchers and technicians and managers. Prior to the establishment of the University of Botswana in 1982 and the upgrading of the Botswana College of Agriculture as a diploma and degree awarding institutions there were few institutions in Botswana that could train scientists and conduct research. For instance in 1970s students from Botswana who wished to undertake higher level education (diploma, degree) in agricultural sciences and allied fields had to go to Luyengo, Swaziland, where the Swaziland Agricultural College and University Centre (SACUC), operating under the umbrella of University of Botswana, Lesotho and Swaziland, offered diploma and degree level education for all the three BLS countries. The collapse of the BLS university system in the late 1970s led to renewed national interest to establish new research performing institutions and to strengthen existing ones.

#### 3.2.2.1.1 *University of Botswana*

The University of Botswana developed from the University of Botswana, Lesotho and Swaziland (UBLS), formerly known as the University of Basutoland, Bechuanaland and Swaziland (UBBS), which had its headquarters in Lesotho between 1964 and 1975. UBLS Botswana presence was limited to the activities of the Division of Extra-Mural Services and a small short-course centre that was built during 1969<sup>13</sup>. Slip of UBLS led to establishment of the University of Botswana and Swaziland, with two constituent University Colleges, was set up in 1976. However, Botswana and Swaziland governments

<sup>12</sup> Members of the TEC are drawn from Government, private sector, tertiary institutions, the community, academic community and students.

<sup>13</sup> The historical overview is derived from the National University of Lesotho <http://www.nul.ls/> and the University of Swaziland <http://www.uniswa.sz/uniswa/history.html>).

realised that in the long term the two university colleges would develop into independent national universities. A development plan for 1975-85 was agreed, with student numbers rising to justify two independent institutions after the 1981/82 academic year; this agreement was effected, as scheduled, in June 1982. Hence, the University of Botswana became established.

Today the University of Botswana and its affiliated institutions are the main centres for undertaking scientific research and the training of present and future generation of researchers and technicians. The University and its affiliated/associated institutions include:

- Bamalete School of Nursing,
- Kanye SDA College of Nursing,
- Botswana College of Agriculture/Faculty of Agriculture,
- Deborah Relief Memorial Hospital School of Nursing, Mochudi, Lobatse College of Education, Francistown College of Education, Serowe College of Education, Tlokweng College of Education, Molepolole College of Education, Tonota College of Education, Francistown Institute of Health Sciences, Gaborone Institute of Health Sciences, Molepolole Institute of Health Sciences, Sorowe Institute of Health Sciences and the Lobatse Institute of Health Sciences.

Only the University of Botswana, the Botswana College of Agriculture, and the Colleges of Education (Molepolole and Tonota) are considered tertiary (third level) institutions. In 2000, an institutional planning document indicated that the University of Botswana was responsible for over 80% of the tertiary education enrolments in 1997/98, which were approximately 10,000, and accounted for 40% of the total post secondary enrolment, which were about 20000 at the time. The recent statistics shows total student enrolment to be 15725 in the 2004-2005 academic year, of which 12771 are full-time. Female student enrolment for the first time exceeded male students. Meanwhile the University is refocusing its academic programmes towards Business, Information and Communications Technology and Science and Engineering. The university is establishing a fully-fledged medical school and has signed agreements with partner medical schools in South Africa and Australia for the transfer of UB premedical students on revised criteria in August 2004 (UB, 2006:11) (the placement of premedical students abroad started in 2002).

#### *3.2.2.1.2 Botswana College of Agriculture (BCA)*

The Botswana College of Agriculture (BCA) was established on the 31st of May 1991 when Act No. 9 - Botswana College of Agriculture Act 1991, enacted by Parliament of Botswana came into effect. A Dean was appointed and started working at BAC in November 1987. Detailed curriculum and regulations for the BSc. degree were prepared and approved by UB Senate in April 1988 and UB Council in June 1988 ([http://www.bca.bw/index\\_gi\\_ie.htm](http://www.bca.bw/index_gi_ie.htm), accessed 28 June 2006).

In light of the UB Council's approval of the curriculum and regulations for the BSc. (Agric.) degree programme, the first cohort of students to register for this programme commenced their second year of study at Sebele with effect from August 1988 (the first year is done under faculty of science UB). Regulations for the diploma programmes as well as their curricula were reviewed and a new diploma programme in agricultural education was established with effect from February 1989. BCA was officially inaugurated, as an Associate Institution of the University of Botswana at the latter's 11th Congregation held at Sebele on 2 November 1991.

At present BCA has five departments comprising: Agricultural Economics, Education and Extension (AEE), Department of Agricultural Engineering and Land Planning (AEL), Department of Animal Science and Production (ASP), Department of Crop Science and Production and Department of Basic Sciences.

The BSc degree programme in Agricultural Education admitted its first cohort of students in August 1996. The Diploma in Forestry and Range Ecology Programme (DFRE) commenced in August 1999 and the Diploma in Horticulture programme admitted its first students in August 2000. The latest programme to be introduced was the BSc Animal Science, which admitted its first cohort of students in August 2002.

### 3.2.2.2 *Public Research Institutes*

Besides the higher education centres other public research institutes perform research and have greater mandate for direct technology transfer and diffusion to address developmental needs. These research institutes are discussed below.

#### 3.2.2.2.1 *Botswana Technology Centre*

The Botswana Technology Centre (BOTECH) was established in 1979 and based in Gaborone. BOTECH is responsible for the adaptation, research, development and application of technologies appropriate to the needs of Botswana. Its aim is to contribute to employment creation, research, and development, and growth of small and medium industries through technology transfer. BOTECH was delegated the responsibility for the assisting in the formulation of the first national S&T policy.

#### 3.2.2.2.2 *The Rural Industries Promotions Company of Botswana*

The Rural Industries Promotions Company of Botswana (RIPCO (B)) was established in 1974 as a company limited by guarantee. It operates under the portfolio responsibility of the Ministry of Commerce and Industry now Trade and Industry until the 6<sup>th</sup> September 2002 when it was transferred to the Ministry of Communications, Science and Technology (MCST) in line with public sector reform. In 1975, the company was given the mandate to establish and operate the Rural Industries Innovation Centre (RIIC) in Kanye as its main operational arm. Since its establishment, RIPCO (B) has been involved in the development and dissemination of appropriate technologies geared towards improving the living standards of the people of Botswana. From 1974 to 1984, the Frederick Ebert Foundation (FEF) in Germany initially funded RIPCO (B). At the end of this period of support, the Government of Botswana took over and provided annual subvention to the company in support of the research and development programme. Government support to RIPCO (B) currently stands at 90% of the budget while the balance of 10% is raised from the company's internal operations.

#### 3.2.2.2.3 *Botswana Institute for Development Policy Analysis (BIDPA)*

The Botswana Institute for Development Policy Analysis (BIDPA) is an independent trust set up by a Presidential Decree. It started operations in 1995 as a non-governmental policy research institution. The two key areas of BIDPA's mandate are development policy analysis and capacity building. Its aim is to promote policy analysis through research, capacity building, assisting organizations or individuals where appropriate, monitoring the country's economic performance and disseminating policy research results. The research function is specialised in the broad areas of Macroeconomic Forecasting and Planning, Microeconomics, International Trade and Finance Economics, Incomes, Welfare and Poverty Economics, and Public Sector Reforms and is headed by Senior Research Fellows. Currently there are 19 researchers consisting of 5 Senior Research Fellows, 6 Research Fellows, 6 Associate Researchers and 2 Research Assistants. In addition, there are 15 support staff members (<http://www.bidpa.bw/>).

#### 3.2.2.2.4 Botswana Vaccine Institute

Botswana Vaccine Institute (BVI) was established in 1980 as a commercial company. The institute is designed to the most advanced specifications available. It is completely self contained; in addition to its production capacity housed in a hermetically-sealed laboratory it has all the facilities for typing of virus, for Foot and Mouth Disease (FMD) research, and for the potency and safety tests carried out in its own facility. The institute has a holding ranch in which cattle specially selected for specific tests are kept. BVI was originally established to insure Botswana's livestock industry freedom against Foot and Mouth Disease and to maintain exports of animal and animal products worldwide.

The Company produces several types of vaccines: viz.: Foot and Mouth Disease (SAT 1, SAT 2, SAT 3, Type 0 and Type A); Normal Rinderpest (Freeze-dried); Thermostable Rinderpest (Freeze-dried); Contagious Bovine Pleuropneumonia (CBPP, Strain T1 -44); Peste des Petits Ruminants (PPR, Freeze-dried); Anthrax (Carbovax), (for Botswana only) and Blackquarter (Asymptol). The Institute has exported vaccines to most of the SADC Countries, Eastern, Central and Western African Countries, some European Countries and some countries in Asia and the Middle East. In 1985, during the 53rd-General Meeting of the OIE, BVI was appointed the Regional Reference Laboratory for Foot and Mouth Disease (FMD) in Africa. BVI is also accredited to FAO (Food and Agriculture Organisation), and SADC (Southern African Development Community).

#### 3.2.2.3 Private Research Institutes

##### 3.2.2.3.1 Veld Products Research & Development (VPR&D)

Veld Products Research & Development (VPR&D) is a Botswana-based Non-Governmental Organisation (NGO), established in 1981 to research and develop a wide range of veld products and to investigate suitable management systems for natural resources in order to ensure sustainable utilisation. VPR&D's main research sites and nursery facilities are located in Gabane, a village 18kms west of Gaborone. A Board of Directors comprised of individuals who are farmers in the Gabane community as well as senior people in Government and in other NGOs governs VPR&D. In addition to its nursery-based research, VPR&D undertakes field activities throughout Botswana and the Southern Africa region. These activities include community-based project activities as well as work on indigenous fruit tree planting trials and agroforestry trial plots located throughout Botswana. The programmes/projects include:

- The Community Based Management of Indigenous Forests (CBMIF) Project
- Indigenous Fruit Tree Research Programme (IFTRP)
- The Community-based Agroforestry Project (CBAP)

##### 3.2.2.3.2 Thusano Lefatsheng (TL)

Thusano Lefatsheng is a rural development organization engaged in agriculture, set up in 1984. It has been involved in two pilot projects in Botswana that involved experimental cultivation and propagation trials of medicinal and aromatic plants and fruit and nut trees. In the context of these pilot projects, a farm was set up in 1986 in the Kweneng District of Botswana that employs rural people from the surrounding area. The farm serves as the organization's research centre and as a demonstration area for local subsistence farmers.

Besides the Veld Products R&D and Thusano Lefatsheng other NGOs that engage in research activities includes the Forestry Association of Botswana (FAB) and Permaculture Trust of Botswana (PTB).

### 3.3 Human capital for S&T

#### 3.3.1 Size and structure of the R&D workforce

The key features of the human capital base for S&T institutions in Botswana include a small base of researchers, small growth in the number of researchers, low GERD per researcher and significant number of female researchers. The total human resources for S&T are estimated at 2165 within the entire S&T system (BNRSTP, 2005:28).

Overall, the University of Botswana, BCA, BTC and DAR forms the bulk of the human resource base of Botswana. In particular, the University of Botswana is one of the largest employers in the country with 2217 staff. Of the total employees, 827 are academic faculty and of those 70 percent are male staff and 65 percent are citizen academic staff (University of Botswana, 2006:7). Out of the 827 academic faculty members, 11% are of Professorial rank (full and Associate), 22% Senior Lecturer and 67% Lecturer. Female staff occupies 30% of academic faculty position with 38% of these at lecturer level compared to 62% of their male faculty who occupy the same position. The professorial rank is dominated academic males (93%) whilst female professors represent (7%). However, 77% of the professorial rank is international staff, while only 23% of the citizens are at the same level. The senior lecturer cadre has 81% males and 19% females, with 64% of the senior lecturer category being international staff while 36% are citizen staff, (University of Botswana, 2006:7). Table 7 gives a list of academic and other staff members at UB for past three years. In early 2004, DAR had total number of 200 research, technical and support staff as presented in Table 8 below.

**Table 7: UB Academic and other staff (2004/05-2006/07)**

Staff Category	2004/05	2005/06	2006/07
Academic	791	796	827
Support & Industrial	1383	1187	1348
Vacancies	401	573	465
<b>Sub-total*</b>	<b>2174</b>	<b>1983</b>	<b>2175</b>
<b>Grand Total</b>	<b>2575</b>	<b>2556</b>	<b>2640</b>

\*The sub-total figures exclude those in vacancies category that are derived from the first two categories.

Source: UB Institutional Fact book 2006.

**Table 8: DAR Research and Support Staff 2004**

Division	Total	PhD	M.Sc	B.Sc	Diploma	Certificate
Arable Research	110	5	14	10	27	54
Animal and Range Research	57	3	10	5	9	30
Support Services	33	0	3	3	13	14
<b>Grand Total</b>	<b>200</b>	<b>8</b>	<b>27</b>	<b>18</b>	<b>50</b>	<b>98</b>

Source: Own compilation from <http://www.dar.gov/dar/temp9.html> last accessed 4 August 2004.

### 3.3.2 Trends in Masters and doctoral enrolments

The enrolment figures for masters and doctoral students/researchers also serve as part of the human capital for science and technology. Masters and doctoral students serve as both an input and output indicators for enrolments and graduation respectively. The University of Botswana offers programmes for master and doctoral degrees following the establishment of the School of Graduate Studies. Table 9 presents the total enrolments for masters and doctoral degree programmes as well as the overall student population at UB from 1998/99 to 2005/06. Enrolment M&D programmes reached over 500 students for the first time in the 2001/02 academic year.

**Table 9: Master and Doctoral student enrolment 1998/99-2005/06**

Programme	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06
Masters	308	382	478	558	683	756	756	899
Doctoral	3	8	9	8	16	13	21	32
<b>Sub-total</b>	<b>311</b>	<b>390</b>	<b>487</b>	<b>566</b>	<b>699</b>	<b>769</b>	<b>777</b>	<b>931</b>
<b>Grand total</b>	<b>8965</b>	<b>10160</b>	<b>11722</b>	<b>12286</b>	<b>12783</b>	<b>15425</b>	<b>15414</b>	<b>15710</b>

\*Grand totals are for enrolment in programme categories including certificates, diplomas and undergraduate and postgraduate studies.

Sources: Own compilation from University of Botswana Fact book various years.

### 3.3.3 Masters and doctoral graduate Output

In Botswana besides those degrees granted at higher educations abroad, the University of Botswana remains the main institutions awarding such degrees. The overall output for university was 3,417 during academic year 2004/05. Of these, 32% were undergraduate certificates and diplomas; 51% undergraduate degrees; 13% postgraduate diplomas and 4% at masters/MPhil/PhD level (UB, 2006:7). Table 10 shows the level of programmes and the total student output between 1997/98-2004/05. Within this period UB has awarded 16 doctoral degrees the highest being 6 in the 2004/05 academic year.

**Table 10: University of Botswana graduate output 1997/98-2004/05**

Level Qualification	of	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05
Certificate								254	190
Diploma								843	877
Undergraduate degree								1630	1733
Postgraduate Diploma								357	462
Masters/Doctoral Degree		103	116	144	149	151	184	183	155
Doctoral Degree		0	1	0	2	0	5	2	6
<b>Grand Total*</b>		<b>2265</b>	<b>2386</b>	<b>2783</b>	<b>3203</b>	<b>3327</b>	<b>3541</b>	<b>3267</b>	<b>3417</b>

\*Grand totals are for all programme categories

Sources: Own compilation from University of Botswana Fact book various years.

### 3.3.4 *Human and institutional capacity development strategies*

The University of Botswana and its affiliated institutions are the main centres for the training of researchers and technicians and other professionals. Under NDP9, UB has committed itself to increase students' enrolment to 15, 000 fulltime and offer some programmes through distance learning. The UB expansion includes construction of multidisciplinary building and other teaching facilities. In addition, it includes the establishment and construction of facilities for the Faculty of Medicine and Allied Health Sciences, which started in 2005. The first graduates are expected in January 2007. At the same time, there are plans to amend the University of Botswana Act to enable it respond to global and local changes in higher education. As part of the Mid-Term Review of NDP9, the government has identified accelerating the transition rate from junior to senior secondary schools as a strategy in expanding the future skills-base (GoB, 2005; 2006).

#### 3.3.4.1 *Establishment of a second university*

There are plans for the establishment of a second public university for science and technology as part NDP9. In November 2005, the Botswana Parliament approved a Bill for the establishment of the Botswana International University of Science and Technology, the construction of which has been estimated to cost P5 billion. Preparatory work for the implementation has also started and the first intake is expected towards the end of NDP9. The University will have the capacity to admit 10000 students when in operation by 2016 (GoB, 2006).

In addition, other projects for tertiary education include construction of the Oodi and Selebi-Phikwe Colleges of Applied Arts and Technology, each with a targeted enrolment of 1200 students. Construction is expected to begin in 2006; The Francistown College of Technical and Vocational Education, with target student enrolment of 1400, which is under construction and due completion in July 2006(GoB, 2006).

#### 3.3.4.2 *Expansion of post-graduate studies*

The first graduate programme at the University of Botswana was introduced in 1983. Today more than 35 Master's and 8 Doctoral programmes are offered. With the introduction of four new graduate programmes in the Faculty of Engineering and Technology in 2005, all faculties of the University now have Masters Programmes. The details about these programmes are provided in the annex.

#### 3.3.4.3 *Plans for National Human Resource Development (HRD) Strategy*

There are plans for a final report on the consultancy for the National Human Resource Development (HRD) Strategy that will be delivered to government by the end of this year. The Tertiary Education Council (TEC) took over the assignment for the project from the Ministries of Finance and Education in 2005 (*Mmegi/Business Week Vol 23(100)*, 6 July 2006).

It is expected that the HRD strategy will raise the country's levels in meeting the economy's human resource demands. TEC says the strategy is important because it will enable Botswana fulfil their potential and assist them contribute to the demands of the society. The HRD would compliment the human resource capital, which has been planned from the National Development Plan (NDP7). Under the NDP7, there were a wide range of government plans, studies, reports and policies, but there was a problem without this kind of strategy. "The common understanding that has emerged is that for Botswana to be acknowledged as a winning nation is rooted in its ability to raise the levels of its people to meet the needs of the economy," a background to the strategy states. So far, TEC states that the project memorandum has been prepared and has been submitted to government.

It is expected that under the strategy, it would be easier to know the work force of the economy and help the government in the graduate unemployment problem. However, the Botswana Confederation of Commerce, Industry and Manpower (BOCCIM) believe that for the strategy to yield positive results there has to be cooperation and integration of systems within the government for monitoring and evaluation purposes. Tebogo Rapitsenyane, spokesperson for BOCCIM says the Department of Student Placement must know how many people they should train in the different fields over a certain period.

This will be based on the strategy that is informed by the needs of the economy. This must be systematically linked to the database in the Department of Labour and Social Security to know which skills are readily available in the economy. "This definitely will be helpful to the Private Sector and even to the Manpower Division at the Department of Public Service Management," he said. BOCCIM argues that currently it is impossible to know in exact quantities the different skills available, and this is very unhealthy because you will continue to train people in saturated skills bracket.

#### 3.3.5 *Scientific mobility*

A 1987 review of the state of conditions of experimental research in the agricultural, engineering, life and physical sciences in Botswana, suggested that outward brain drain was not a major problem in the country. The report noted that Botswana professionals who studied abroad also readily returned home. However, the assessment was that there was internal brain drain at that time from research institutes by Botswana professionals to join other parastatals and the private sector mainly due to general unsatisfactory terms of service in research and teaching but there was a net gain in migration with most research institutes staffed by expatriates in key positions (see Tebicke, 1987). The key question here is how different is the current situation in Botswana regarding scientific mobility two decades later?

Available figures from Botswana indicate that over 90% of doctors, 61% of pharmacists, and 64% of radiography cadre in the health sector facilities are expatriates. As a result, the country is making great efforts to expand local training capacity and to increase the number of health students to address the problem (Gaolathe, 2005). At the University of Botswana, which is one of the key research performing

units in the country, 77% of the professorial rank is international staff, while only 23% of the citizens are at the same level. The senior lecturer level international staff represents 64% of this category, while 36% are Botswana nationals (University of Botswana, 2006:7). Table 11 below presents the number of academic staff by gender and nationality at UB.

**Table 11: UB Academic Staff by Gender and Nationality (May 2006)**

Staff Category	Gender		Nationality		Total
	Male	Female	Citizen	International	
Professor	36	2	1	37	38
Associate Professor	48	4	12	40	52
Senior Lecturer	145	33	64	114	178
Lecturer	347	212	463	96	559
<b>Total</b>	<b>576</b>	<b>251</b>	<b>540</b>	<b>287</b>	<b>827</b>

Source: UB Institutional Research Department of Institutional Planning UB Fact Book 2005/06, May 2006

The government has realised the importance of general net inflow of labour into the country and to speed up the processing of work and residence permit, it has established a second Regional Immigrants Selection Board in Gaborone. Since the Board started its work in May 2005, the turn around time for processing of work and resident permits has reduced from about 12 months to 2 months.

### 3.4 *Financial resources (funding)*

In general, Africa's investments in R&D activities remain very low in comparison to other regions and at the individual country level, although there has been encouraging signs of increasing investments, or some governments' interests to expand their spending on science, technology and innovation activities on the continent through various policy developments and project initiatives.

#### 3.4.1 *National financial resources*

Botswana is one of the countries, which over the past decade, has engaged in new policy formations and efforts to create a new funding agency to strengthen its national research and innovation systems. For example, in July 1998 the Parliament of Botswana approved its first national S&T Policy. Although no financial targets were set in the policy document, the government of Botswana has taken note of the important role of S&T for economic growth and development seriously and efforts are being made to increase funding and create the necessary infrastructure and a congenial environment. The government announced the creation of a new Ministry of Communications, Science and Technology in September 2002. As part of the 9<sup>th</sup> National Development Plan (NDP9) presented in November 2002, the new ministry has been allocated a budget estimate for P1.1 billion to be spread over the NDP9 period (2003/04-2008/09).

During the 2005 fiscal year the science ministry was allocated P261 million of the development budget. In all, four projects including ICT Facilities (P76 million), BTC Finances (P70 million), Development of Department of Information and Broadcasting (P69 million) and Science and Technology Research Institutions (P25 million) together accounted for P240 million or 92% of the total budget of the MCST. In 2006 national development budget MCST was allocated P154 million. In the 2007/08 financial year, MCST has been allocated P482 million (or 2.7%) of the national recurrent budget. Ministry of Education has allocated P5.0 billion (or 28.2%). Under the development budget of

P7.26 billion, MCST has been given a share of P347 million (about 5%). Three projects comprising BTC Finances ((214 million), Development of Department of Information and Broadcasting (P53 million) and Science and Technology Research Institutions (P32 million) together accounted for 86% of the total development budget of the MCST. The Ministry of Education is allocated P584 million (8%) of the development budget. In addition, there is also a ring-fenced allocation of P305 million under the Tertiary Education Development Fund during the 2007/08 fiscal year (the TEDF was allocated P235 million in 2006/07).<sup>14</sup>

In February 2005, the Government announced that it is commissioning the preparation of a National Research Science and Technology Plan, which was to be completed by the middle of this year. This Plan will identify national research priority areas and show the direction of investments. In addition, in the course of 2005 a bill for the establishment of the Botswana Research, Science and Technology Investment Agency proposed in 2000 will be put before the National Assembly. The new Agency will co-ordinate and monitor all government R&D funding.<sup>15</sup> An inventory by CSIR (2005) reported that Botswana spends about 0.43% of GDP on research and development (BNRSTP, 2005).

The University of Botswana receives the bulk of funding through government subvention. The UB commits at least 2% of its funding to support faculty research (UB, 2006). In 2004-05, the University Research Advisory Committee allocated P1.8 million to the annual funding round to faculties for research. The requested amount is said to have exceeded the available funds three-fold. The external funding received for new and renewed grants for research outreach and teaching was P10.5 million in 2004-05 as compared with P10.8 million in 2003-04. Currently, the University's Research Department supports over 130 active projects (UB, 2005)

To encourage the uptake of research and promote innovation the MCST proposed a new strategy that will encourage public-private partnership whereby a matching funding is provided through an innovation fund to support collaborative. This proposal endorsed by the new BNRSTP includes:

- Technology Linkup Grants- aimed at increasing the awareness of, and facilitating access to, technology or technology capabilities new to the private sector;
- Grants for Private Sector R&D- aimed at increasing the number of successfully commercialised products, processes and services through increased levels of enduring R&D investment within firms;
- Technology Fellowships for Industry and Business- fellowships to employees in private firms to build an enhanced level of S&T-based human capital within commercial R&D environments; and
- Public-Private Research Consortia- investment partnerships between private sector firms and the Government leading to successfully commercialised, high technology, high value products, processes and services through targeted R&D (BNRSP, 2005:17).

Tables 12 and 13 represent estimates for development and recurrent budgetary allocations for some line ministries in Botswana. To boost investments in R&D and to achieve at least 1% of GDP on R&D by 2011/12 fiscal year, the BRSTP proposes the following expenditure by government to reach the goal as indicated in Table 14. The budget allows for an increase in the Innovation Fund to 15%; Line funding reducing from 65% to 40% and competitive funds allocated to Centres of Excellence and Mission-focused Programmes rising from 30% to 45% of total government allocation over a 6-year period (BRSTP, 2005:50).

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<sup>14</sup> TEDF funding support activities including the development of the Botswana International University of Science and Technology, UB expansion projects including School of Medical Sciences.

<sup>15</sup> Republic of Botswana Budget Speech 2005. Delivered to the National Assembly on 7 February 2005 by Baledzi Gaolathe, Minister of Finance and Development Planning.

However, Botswana is one the few countries in Africa where under-expenditure of allocated national budget to both the MCST and Ministry of Education have occurred. For instance, in the 2005/06 financial year there was an under-expenditure of P667 million, which represented about 15% of the total P4.45 billion revised development budget. Of this amount the Ministries of Communication, Science and Technology and Education accounted for P66 million and P81 million under-expenditure respectively. These amounts exclude the under-expenditure of the recurrent budgets.

**Table 12: Botswana Estimates of Development Budgetary Allocations for Selected Ministries in Fiscal Year 2005-/06-2007/2008 (P millions unless otherwise stated)**

<b>Ministry</b>	<b>2005/06 (P4.86b)</b>	<b>2006/07(P5.8b)</b>	<b>2007/08</b>
Communication, S&T*	261	154	347 (5%)
Education	400 (8%)	528 (9%)	584(8%)
Agriculture	74	105	162 (2.2)
Health	606(12%)	577 (10%)	637(9%)
Minerals, Energy, Water Resources	493(10%)	622 (10.7%)	636 (9%)
Environment and WT	100	172	189 (2.6%)
Trade and Industry	51	71	93 (1.3%)

\*In 2006 MCST allocation came from P894 million (15% of development budget)

Sources: Own compilation from Botswana Budget Speech various years

**Table 13: Botswana Estimates of Recurrent Budgetary Allocations for Selected Ministries in Fiscal Year 2005/2006-2007/2008 (P millions unless otherwise stated)**

Ministry	2005/06 (P16.80b)	2006/07(P16.84b)	2007/08
Communication, S&T			482 (2.7%)
Education	4.28 billion (30%)	4.52 billion (27%)	5.0 billion (28.2%)
Agriculture	672	648 (4%)	695 (3.9%)
Health	1.34 billion	1.39 billion (8%)	1.57 billion (8.9%)
Minerals, Energy, Water Resources			541 (3.1%)
Environment and WT			330 (1.9%)
Trade and Industry			311 (1.8)

(--) figures represent the percentage of budget allocation to each ministry.

Sources: Own compilation from Botswana Budget Speech various years

**Table 14: Estimate of total government expenditure on R&D in current prices for 2006/07-2010/11(thousands of Pula)**

	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	Totals
Mission	28049	40531	56902	73063	93162	116435	408142
Centres	56099	81062	113804	146127	186324	232869	816285
Line	182321	221077	260801	281013	299449	310492	1555153
Innovation	14025	25792	42676	61822	86508	116434	347257
<b>Total</b>	<b>280494</b>	<b>368462</b>	<b>474183</b>	<b>562025</b>	<b>665443</b>	<b>776230</b>	<b>3126837</b>
<b>GDP</b>	<b>56098880</b>	<b>61410230</b>	<b>67740400</b>	<b>70253210</b>	<b>73938150</b>	<b>77623079</b>	<b>407063949</b>
<b>GERD</b>	<b>0.50%</b>	<b>0.60%</b>	<b>0.70%</b>	<b>0.80%</b>	<b>0.90%</b>	<b>1.0%</b>	

Source: adopted BNRSTP, 2005, p61.

#### 3.4.1.1 Botswana Research Science and Technology Funding Agency

The establishment of the Botswana Research Science and Technology Funding Agency (BRSTFA) was approved in 2002. DRST proposes to formalise BRSTFA through a Bill in Parliament and provide seed money to start its operation. The agency will be a parastatal under the ministry (MCST) and will promote competitiveness in government-funded research in S&T. The agency will administer public funds to ensure that research in S&T benefits Botswana socio-economically. BRSTFA will target research investments that will result in better lives for Botswana, positive environment for achievement of the national policy goals of economic diversification, employment creation, poverty alleviation, human resource development and science and technology development and endeavour to promote public-private partnerships (<http://www.mcst.gov.bw>, accessed 11 July 2006).

### 3.4.1.2 *Training of Scientists and Technologists Fund*

The fund seeks to provide training opportunities for Botswana in the fields related to research science and technology with the aim of equipping such candidates with strategic and scarce skills that can drive Botswana to achieving the goals of vision 2016 especially in an innovative and prosperous nation (<http://www.mcst.gov.bw>, accessed 11 July 2006).

### 3.4.2 *International donor funding*

In order to mitigate the impact of HIV/AIDS, the Government has joined in a public-private partnership with the Bill & Melinda Gates Foundation, Merck & Co., Inc and other non-governmental organizations (NGOs) as well as some bilateral and multilateral development assistance agencies, to undertake several large-scale projects on HIV/AIDS.

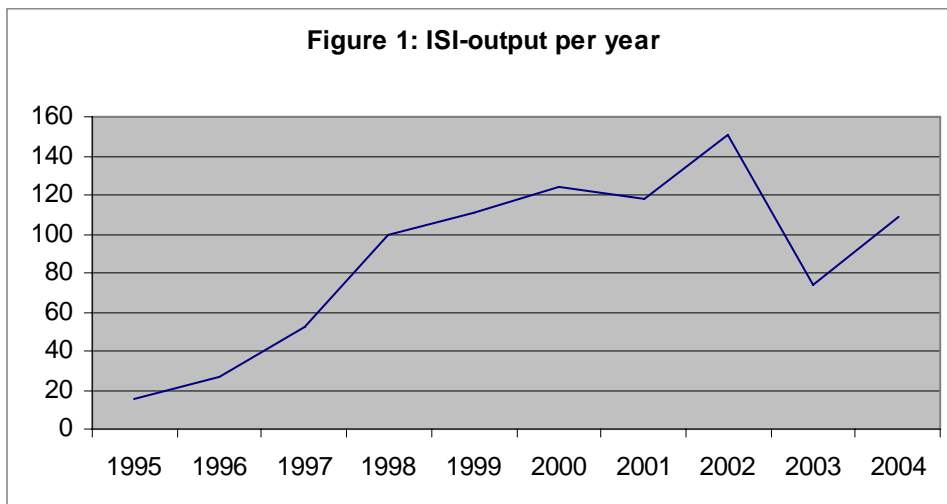
For example, in 2003, President George W. Bush announced the Emergency Plan for AIDS Relief, a five-year, \$15 billion U.S. Government initiative that aims to provide treatment to at least two million HIV-infected individuals, prevent seven million new HIV infections, and provide care and support to 10 million people living with and affected by HIV/AIDS, including orphans and vulnerable children. To help attain these goals, the U.S. Government is rapidly expanding its programs and engaging new partners in 15 focus countries, including Botswana. Under the Emergency Plan, Botswana will receive \$17.9 million in 2004 to support a comprehensive treatment, prevention, and care program (USAID website).

Future challenges for the government include continuing to address the high fertility and infant mortality rates, the needs of HIV/AIDS orphans, and the lack of trained and qualified personnel in sexual and reproductive health.

### 3.5 *Research output*

It is standard practice to measure research output in country studies in terms of peer-reviewed article output. Information on other forms of research outputs (books, conference proceedings, chapter in books and so on) are usually not available in standard form neither always readily available at country level. In cross-country comparisons, it has also become standard practice to use output in one of the ISI-indexes (SCI, SSCI or AHI) as sole source. This inevitably introduces various kinds of biases into such comparisons as the ISI-indexes do not cover all countries, languages and disciplines equally well. It is a well-established fact that the coverage of those countries on the margin of world science – which is true for most if not all of Africa – is particularly poor.

Although we present the ISI-output for Botswana below, these caveats need to be taken into account. Given the dominance of agricultural research for the country, it should also be noted that the ISI-coverage in this field is also less comprehensive than other indexing systems dedicated to agricultural research (such as the CAB). Using South Africa as a comparison (for which we do have these figures), we would estimate that one needs to at least double the ISI-output figures to get a more realistic estimate of total article output for Botswana. Our figures show that Botswana produced 880 articles in ISI-journals between 1995 and 2004. On this basis, our estimate for total output would be in the region of 1700 – 1800 articles. Such an estimate would especially include the social sciences and humanities production that are often largely published in local journals.



The ISI-data for Botswana was further analysed to produce institution-level data (next Graph), as well as a profile of scientific collaboration both within and outside the country. The profile presented on the next page reveals some interesting trends:

- The complete dominance – as one might expect - of researchers at the University of Botswana in the production of academic journal articles (95% of all outputs produced by staff at UB).
- The small extent of international and even within-country level collaboration as measured by co-authorship. There is no evidence of collaboration between staff of the University and researchers at the Department of Agricultural Research. There is also very little international collaboration (only with academics at Yauonde and Jomo Kenyatta University (the links shown with Swaziland are co-appointments of the same staff member).

The overall profile shows that academics are not typically involved in collaborative efforts. Whether this is due to historical reasons (relative recent establishment of the University), or ICT-barriers, lack of funds or other factors, is not clear.

In an attempt to get some idea of local research production not covered in the ISI-journals, we present information on journals published in Botswana below. Although we do not have information on the number of articles produced in these journals, it gives a sense of (1) the areas in which local production is prominent; and (2) the extent of local knowledge production.

The oldest local journal, according to our information, is the *Botswana Notes and Records* which has been published by the Botswana Society since 1969, a year after the society was established by the National Museum and interested individuals. Most of the local journals are published at the University of Botswana and include:

- *Botswana Notes and Records*, first published in 1969 (Botswana Society)
- *Pula: Botswana Journal of African Studies* first published in 1979 (UB).
- *African Journal of Library, Archives and Information* (UB) (indexed in AJOL)
- *Botswana Journal of Technology* 1993(UB) (indexed in AJOL)
- *Botswana Journal of Agricultural and Applied Science* (BCA)
- *Botswana Journal Business* 2002 (UB)
- *Botswana Journal of Economics* (UB)-launched 2004

- *University of Botswana Law Journal (UB)*–launched 2004
- *Southern Africa Journal of Mathematics and Science Education* 1994 (UB)

If one also takes the view that Research Masters and Doctoral students are research “outputs”, we can get another view on research production in the country by looking at the data in Table 15 below.

**Table 15: Post-graduate output**

Level of Qualification	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05
Masters Degree	103	115	144	147	151	179	181	149
Doctoral Degree	0	1	0	2	0	5	2	6
<b>Total</b>	<b>103</b>	<b>116</b>	<b>144</b>	<b>149</b>	<b>151</b>	<b>184</b>	<b>183</b>	<b>155</b>

Sources: Own compilation from University of Botswana Fact book various years.

### 3.6 *Technological innovation*

Business expenditure on R&D (BERD) and patent data are often used as a measure of a country’s technological performance. This implies that indicators for technological innovation are useful for both input and output measurements. Similarly, the significance of technology in promoting human development led to the introduction of the *Technology Achievement Index (TAI)* by the United Nations Development Programme in its annual Human Development Report (HDR) in 2001. The TAI captures how well a country is creating and diffusing technology and building human skill base- reflecting capacity to participate in the technological innovation of the network age. This composite index measures achievements, not potential, effort or inputs. The indicators selected relate to important technology policy objectives for all countries, regardless of their level of development. These are creation of technology measured by the number of patents granted to residents and by receipts of royalties and license fees from abroad (see technology balance of payments); diffusion of recent innovation measured by the number of internet host per capita; diffusion of old innovation (telephone per capita, electricity consumption per capita); and human skills as measured by mean years of schooling and gross tertiary science enrolment ratio (UNDP, 2001:46). In the first issue of TAI for 72 countries there were no scores for Botswana in this index in 2001, this was because of the lack of data for calculating at that time. The TAI score for 2004 is estimated at 0.377 but comparable scores for other countries for the same year/period are not available (UNDP, 2005:50).

#### 3.6.1 *Technology balance of payments*

The technology balance of payments measures international transfer of technology including - licensing contracts, purchases of patents, expertise and research, and technical assistance. Unlike R&D expenditure, these are payment for production-ready technologies. Although the technology balance of payments reflects a country’s ability to sell its technology abroad and its use of foreign technologies, a deficit does not necessarily indicate low competitiveness. The Table 16 shows the royalties and license payments and receipts.

**Table 16: Botswana technology balance of payments**

Type of activity	1998	1999	2000	2001	2002	2003	2004
Receipt (US\$ million)	0	--	--	0	--	0	3
Payments (US\$ million)	9	6	--	6	--	8	12

Source: Own Compilation from World Bank's *WDI* various years

### 3.6.2 Patents

Botswana has a low rate of market uptake of the outcomes of the research done in the country and output levels are below par for all forms of registered intellectual property and technology demonstrations. A wider search on all patents registered over the period 1994 to 2004 indicates that only 1 US patent and 4 EU patents were granted to Botswana citizens out of a total number of 20 applications. In the period 2001 to 2003 there were 3 Patent Cooperation Treaty (PCT) filings (equivalent to international applications) (BNRSTP, 2005:17). Table 17 shows patent applications filed from 1998 to 2002.

**Table 17: Patent Applications filed**

Type of activity	1998	1999	2000	2001	2002
Residents	7	--	1	2	0
Non-residents	85	--	15	56	10

Source: Own Compilation from World Bank's *WDI* various years

Besides the US and EU patent databases, there are two Regional Organisations which deal with issues of intellectual property rights (IPRs) in Africa. These are the African Regional Industrial Property Organisation (ARIPO) and the African Intellectual Property Organisation (OAPI) based in Harare and Yauonde respectively. Botswana is a member of ARIPO, an inter-governmental industrial property organisation created in 1976 at a Diplomatic Conference in Lusaka, Zambia. The Treaty creating ARIPO (known as the Lusaka Agreement) entered into force in 1978. The headquarters of ARIPO are in Harare, Zimbabwe. At present, 15 States are members of ARIPO. The rest are Gambia, Ghana, Kenya, Lesotho, Malawi, Mozambique, Sierra Leone, Somalia, Sudan, Swaziland, Tanzania, Uganda, United Republic of Tanzania, Zambia and Zimbabwe. One of the main objectives of the modernization, harmonization and development of the industrial property laws of its members as well as assisting its members in the acquisition and development of technology relating to industrial property.

In December 1982, the Council of ARIPO adopted the Protocol on Patents and Industrial Designs (Known as the Harare Protocol). This Protocol empowers the Office of ARIPO to grant patents and register industrial designs and to administer the granted patents and registered industrial designs, on behalf of the Contracting State (i.e. State that are party to the Protocol). A Patent granted under the Harare Protocol has the same effect in the designated Contracting State as a national patent. The Protocol entered into force in 1984. Since that date the following countries Botswana, The Gambia, Ghana, Kenya, Lesotho, Malawi, Mozambique, Sudan, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe are a party to the Protocol. Some Contracting States have already incorporated the Protocol into their national laws; for the other Contracting States, incorporation is under way. Due to the significance of IPRs issues, ARIPO, OAPI and WIPO (World Intellectual Property Organisation) have an agreement that enables them to meet at least once every year and plan a strategy in matters

relating to IP. However, it unclear how many patent applications Botswana have filed or obtained at ARIPO.

In addition, Botswana enacted the Patent and Trademark Act and Industrial Property Act in 1997, which provide for the protection of domestic and foreign holders of patents, industrial designs, and trademarks. This Act makes Botswana an original registry of intellectual properties, rather than registering in South Africa or the UK to be accorded protection as done previously in Botswana. The country also accented to the PCT in 2004.

### 3.6.3 *Innovation strategies*

In February 2007, the Botswana government announced the plan establishment of an innovation hub in Gaborone during the course of the year. The major objectives of the hub identified include:

- Attracting of FDI in high technology businesses such as information and communications technology and biotechnology;
- Encouraging and supporting the start-up of innovative technology based businesses with a focus on exports;
- Accelerating growth of existing businesses by creating an environment of innovation, and helping businesses to commercialise innovative products, processes and services;
- Attracting research and development activities of leading multinational corporations to Botswana.

The innovation hub is expected to improve Botswana's ability to compete in the global market because of a productive labour force with technical skills and training provided by the hub (GoB, 2007).

### 3.7 *Conclusion*

Science, technology and innovation are considered as crucial areas of development in Botswana's drive towards achieving the national Vision 2016 and the UN Millennium Development Goals objectives and further transformation into a knowledge-based economy. To achieve both the MDGs and Vision 2016 objectives, the government argues that it must attain an annual national economic growth rate of 7% and 8% respectively. Such a noble development objective cannot be achieve without appropriate institution and policies to guide the development projects and programmes especially in the medium to long-term with concrete implementation strategies.

Therefore, the Government of Botswana created the Ministry of Communications, Science and Technology (MCST) in 2002, "primarily to turn Botswana into an information and knowledge-based economy". This means that information and communications technology is one of the key national research and innovation priority areas and the ministry as one of the critical S&T governance institutions in the country. There is a process to speed up the diffusing of ICTs to rural areas and as a result, draft rural telecommunications strategy has been published in June 2006. In addition, Radiation Protection Bill was passed to promote the safe development and applications of nuclear science and technology in the country's development efforts in September 2006. Other important S&T governance institutions are National Commission for Science and Technology (NCST) and Tertiary Education Council (TEC). The TEC is currently driving a process towards the development of national human resources strategy for the country. The formulation of the National Master Plan in Arable Agriculture and Dairy Development (NAMPAADD) and biotechnology and biosafety framework give priorities and importance to the line ministry although the share of agriculture sector contribution to GDP is now less than 3%, with beef the second largest single export product after diamonds. Given the significance of the mining sector, Ministry of Minerals, Energy and Water is equally important. Indeed, one key strategy in the economic diversification programme is to improve the beneficiation of minerals by adding value to mineral resources extracted in Botswana.

The University of Botswana, the Botswana College of Agriculture, and the Colleges of Education; the Department of Agricultural Research (DAR), the Rural Industries Promotions Company (RIPCO (B) with Rural Industries Innovation Centre (RIIC) in Kanye as its main operational arm, Botswana Institute for Development Policy Analysis (BIDPA); Botswana Technology Centre (BOTECH); Botswana Vaccine Institute (BVI) and the National Food Technology Research Centre (NFTRC) are currently the main research and development performing institutions in the country. They are the institutions that that will drive future the process of technology innovation and diffusion.

The Botswana–Harvard School of Public Health AIDS Initiative for HIV Research and Education (BHP) is an important collaborative research and training initiative between the Government of the Republic of Botswana and the Harvard AIDS Institute (HAI) initiative that has evolved since 1996. The Botswana-Harvard AIDS Institute Partnership has grown into a fully outfitted research laboratory and training centre with a new state-of-the-art laboratory building commissioned in December 2001. This HIV Reference Laboratory is of a calibre and scale currently unmatched in Africa. It is a very important research facility that promote co-operation with other institutions and researchers in Africa and internationally.

However, the government believes that the current research and teaching infrastructure is still inadequate to address future needs for skilled human resource and building an innovative economy and is therefore expanding the infrastructural base by creating new institutions through appropriate legislative processes. The expansion of research and educational infrastructure will also increase Botswana’s capacity absorb more students from the SADC region and the rest of the continent.

All these processes require increasing investments in research and development and to facilitate the transfer and diffusion of knowledge. Nevertheless, the present level of investment on R&D is very low hence; there are plans to create a new funding agency that support science and innovation activities in the country.

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## Appendix A: Highlights of institutional development

Pre-independence	Public agricultural research in Botswana began in the 1930s with the establishment of an experimental station that focused on a variety of crops at Mahalapye, and livestock research conducted at a ranch at Morale respectively.
Late 60's	The Department of Agricultural Research (DAR) was established under the Ministry of Agriculture (MoA), with research activities limited to crop production and pastures. In 1961 veterinary research in Botswana was strengthened with the establishment of a veterinary laboratory in Mafikeng. In 1968 the National Veterinary Laboratory was transferred to the newly established capital Gaborone. Botswana's research infrastructure grew considerably, and several research stations were created, including a new headquarters at Sebele near Gaborone in 1968.
1970's	<p>The Animal Production Research Unit (APRU) was created in 1970 to broaden DAR's focus to livestock research. APRU's research programmes and capacity increased considerably to encompass 17 research sites throughout the country. At present, DAR has the mandate to develop technologies, to improve productivity and competitiveness in both arable and livestock farming. It operates with two main divisions, namely the Crop Research Division and Animal Production and Range Research Division.</p> <p>RIPCO (Rural Industries Promotion Company) was established in 1974 to promote rural industrialization through development and dissemination of appropriate technologies. This is geared towards the creation of employment and improvement of life of Botswana, and attainment of economic self-sufficiency. RIIC (Rural Industries Innovation Centre) was later created as a subsidiary operational research arm of RIPCO, as a national appropriate technology centre.</p> <p>In 1979 BOTECH (Botswana Technology Centre) was established to promote S&amp; T through R &amp; D, technology transfer, policy development, industry support, economic analysis, and informational and educational activities. BOTECH core strengths are being developed in renewable energy technologies, electronics, architecture, civil engineering, scientific and technological information. BOTECH is linked to many international networks and represents Botswana on the Commonwealth Science Council.</p>
1980's	<p>In 1980, the Botswana Vaccine Institute was established. It is a reference laboratory for foot and mouth disease in Africa. In 1981, the Veld Product Research (VPR) was established by a private researcher who was earlier contracted by the GoB to survey the commercial potential of all the indigenous plants and insects in Botswana.</p> <p>The University of Botswana (UB) was established in 1982 as a national university. At present, it has Faculties of Business, Education, Engineering &amp; Technology, Humanities, Science, and Social Sciences, together with a School of Graduate Studies and a Centre for Continuing Education. It also includes the Harry Oppenheimer Okavango Research Centre (HOORC) set up by UB as a multidisciplinary wetlands research centre that specializes in natural resource management research in the Okavango River Basin. This is to support the development of sustainable resource use by local communities in the whole river basin so as to promote its long-term conservation.</p> <p>Over the past two decades, UB has changed from being a mere teaching university to a recognized institution in S &amp; T research activities. Coordination of S&amp;T research activities has recently been decentralized from a former National Institute of Development Research and Documentation to a Directorate of R &amp; D with the roles including strategic planning of research, facilitating R &amp; D, capacity building and training, quality management, external relations, commercialisation of research outputs and research coordination.</p> <p>Recently, the Faculty of Science at UB submitted a proposal to set up an Ethno-Innovation Centre to embrace a multidisciplinary approach to research in the three broad areas of health, the environment and agriculture, The proposal takes cognizance of the fact that Indigenous Knowledge Systems (IKS) are a vital source of knowledge development, innovation and entrepreneurship. It derives its concept from the statement in the Botswana Vision 2016 that <i>While much can be borrowed from other countries, we will need to look within our resources and culture to find the sources of innovation that will allow us to shape our own future.</i></p>
1984	<p>In 1984, Thusano Lefatsheng was established as an NGO subsidiary of Veld Products Research to engage in the commercialization of veld products, while research into indigenous fruit tree domestication, developing methods for harvesting devils claw, the processing of wild foods, and investigations into traditional medicine continues. A number of (foreign registered) patents have emerged from this venture.</p> <p>Still in the same year, the FTRS (Food Technology Research Services) was established to provide technical assistance to the food and agro-industry, assist in job creation, contribute to import substitution, expand opportunities in the food sector, enhance the quality of food, and promote utilization of local material. It also maintains programme at entrepreneurial level. Botswana Food</p> <p>Laboratories later emerged as a pilot project. The present day National Food Technology Research Centre (NFTRC) is an off-shoot of these earlier efforts in the area of food research.</p>

1990s	<p>In 1991 the BCA (Botswana College of Agriculture) was established as a parastatal under the Ministry of Agriculture. BCA is presently an associate institution of UB, operating like its Faculty of Agriculture. It provides education &amp; training in the science and practice of agriculture, forestry, and animal health. Its research areas include agricultural economics, education and extension, agricultural engineering and land planning, animal sciences and production, basic sciences, crop sciences and production. It has contributed to increasing the critical mass of potential agricultural S&amp;T researchers in the country.</p> <p>The Standards Act was adopted by parliament in 1995, and the Botswana Bureau of Standards (BOBS) was established as Parastatal in April 1997. BOBS is governed by a 12 member Standards Council. It is the official body responsible for all issues related to standardization and quality assurance at the national level. BOBS is also a full member of the International Organization for Standardization (ISO) and the national contact point for all SADC programmes and Standardization and Quality Assurance.</p> <p>The Telecommunications Act was promulgated in 1996. This culminated in setting up the Botswana Telecommunication Authority and enabling laws to regulate the provision of telecommunication services and licensing of providers. This has resulted in the deregulation of telecommunications provision services with significant impact on the ICT industry in general, accelerating development in this sector with spin-off effect on S&amp;T informational activities.</p> <p>In 1999 FTRS was reconstituted into NFTRC (National Food Technology Research Centre). This was to broaden its research and innovation scope in the area of food science and technology.</p>
2000's	<p>In 2000, the report of a commissioned study on Focusing Investment in Innovation - the co-ordination and rationalisation of Research S&amp;T and Innovation in Botswana [Milne et al, 2000], was released. Following this report the National Commission for S&amp;T (NCST) as recommended in the BNSTP as formed. In the same year the Copyright Act was enacted. In 2001 the Botswana-Harvard AIDS Institute Partnership research laboratory dealing with HIV/AIDS related research, was established as part of the efforts to tackle the problem of HIV/AIDS endemic through S&amp;T research.</p> <p>In 2002, the Ministry of Communications, Science &amp; Technology (MCST) was created as an umbrella ministry for S&amp;T institutions including the Botswana Telecommunications Authority.</p>

**Sources:** Sunday O. Ojo in SCOPE project 2005 and own compilation.

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## Appendix B: Summary of major policies driving research and institutional programmes

Policy/Act	Date
National Biosafety Framework (NBF) for Botswana	2006
Botswana National Research, S&T Plan (BNRSTP)	2005
Tertiary Education Policy for Botswana: Challenges and Choices	2005
Energy Policy	2005
Tertiary Institutions (Registration of Public and Private)	2005
National ICT Policy	2004
National Master Plan in Arable Agriculture and Dairy Development (NAMPAADD).	2002
Research Guideline draft	2004
Ninth National Development Plan (NDP 9)	2003
A Framework for a Long Term Vision for Botswana -Vision 2016	1997
Tertiary Education Act 1999	1999
Industrial Development Policy for Botswana	1998
Botswana National S&T Policy (BNSTP)	1998
National Policy on Vocational Education and Training	1997
Telecommunications Act	1996
Telecommunications Policy for Botswana	1995
Revised National Policy on Education	1994
National Policy on Agricultural Development	1991
National Policy on Natural Resource Conservation	1990

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