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GO→SPIN
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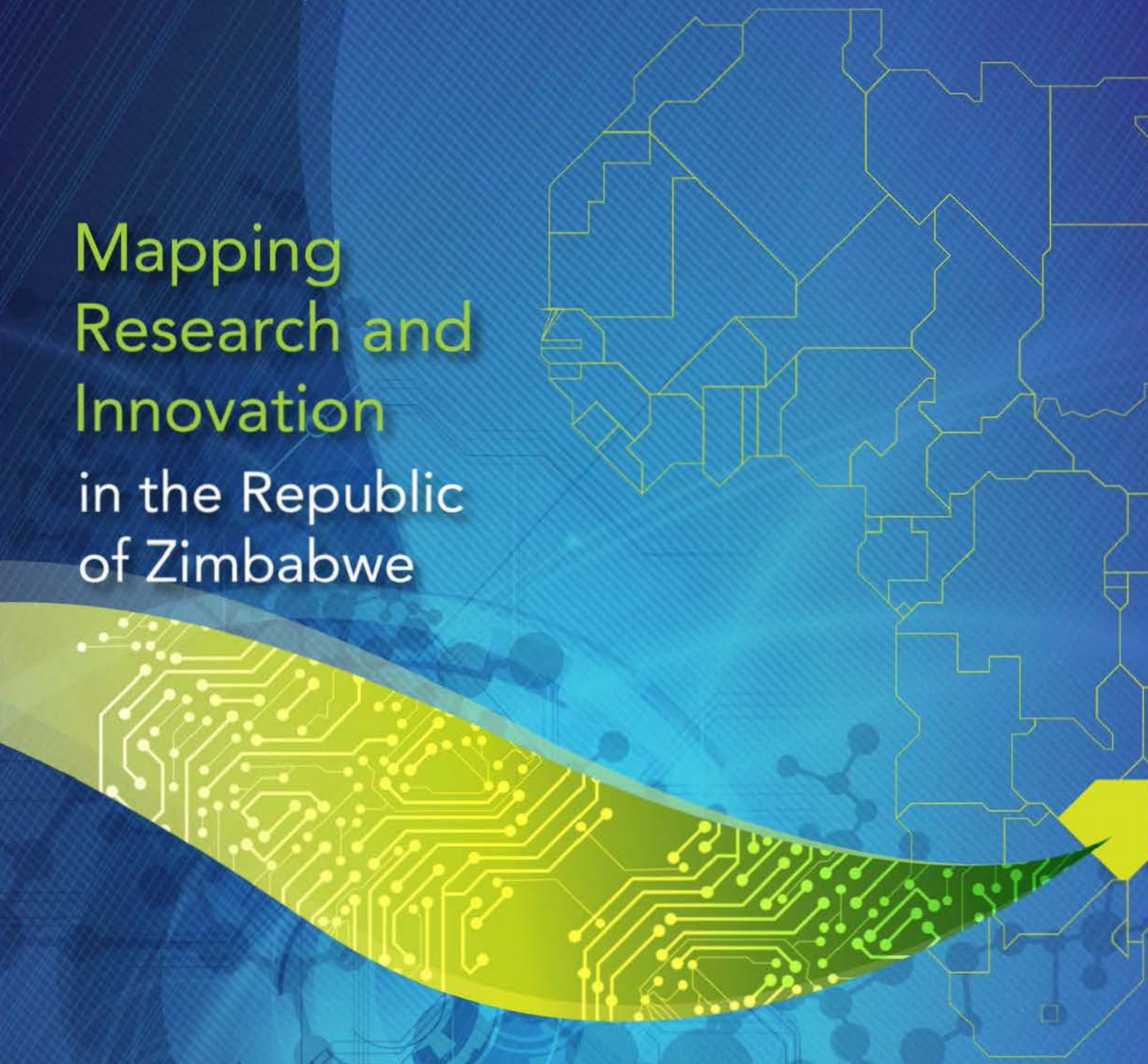
AND INNOVATION POLICY INSTRUMENTS

Mapping Research and Innovation in the Republic of Zimbabwe



GO→SPIN Country Profiles in Science, Technology and Innovation Policy

Volume 2

Mapping Research and Innovation in the Republic of Zimbabwe

GO→SPIN Country Profiles in Science, Technology and Innovation Policy

Volume 2

In co-operation with the Ministry of Higher and Tertiary Education, Science and Technology Development of the Republic of Zimbabwe

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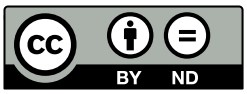

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Acronyms and Abbreviations

AECID	Spanish Agency of International Cooperation for Development (Agencia Española de Cooperación Internacional para el Desarrollo)
ARIPO	African Regional Intellectual Property Organization
ASTI	Agriculture Science and Technology Indicators
ASTII	African STI Indicators Initiative (NEPAD)
AOSTI	African STI Observatory (African Union)
COMESA	Common Market for Eastern and Southern Africa
CZI	Confederation of Zimbabwe Industries
GDP	Gross domestic product
GO→SPIN	Global Observatory of Science, Technology and Innovation Policy Instruments (UNESCO)
GOZ	Government of Zimbabwe
EPO	European Patent Office
FDI	Foreign direct investment
FTE	Full-time equivalent
HDI	Human Development Index (UNDP)
ICTs	Information and communication technologies
IDRC	International Development Research Centre (Canada)
IPR	Intellectual property rights
ISCED	International Standard Classification of Education
MDG	Millennium Development Goals
MINHTESTD	Ministry of Higher and Tertiary Education, Science and Technology Development (Zimbabwe)
NBA	National Biotechnology Authority (Zimbabwe)
NEPAD	New Partnership for Africa's Development (African Union)
OECD	Organisation for Economic Cooperation and Development
PPP	Purchasing power parity
RCZ	Research Council of Zimbabwe
R&D	Research and development
SADC	Southern African Development Community
S&T	Science and technology
SETI	Science, engineering, technology and innovation
STI	Science, technology and innovation
STIIP	Science, Technology and Innovation Information Platform
STPI	Science and technology policy instruments
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UIS	UNESCO Institute for Statistics
USPTO	United States Patents and Trademark Office
WIPO	World Intellectual Property Organization
ZIMSTAT	Zimbabwe National Statistics Agency

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Foreword by Irina Bokova

Science, engineering, technology and innovation hold key answers to the new, complex challenges facing governments. These cannot be stand-alone processes but rather should be integrated into societies through partnerships, through strong links between science, policy and society, through effective national policies and robust systems of governance and through science education. Innovation is not a decision but an ecosystem that is a foundation for knowledge societies and sustainable development.

Governments need tools to map the landscape of science, technology and innovation (STI) in their countries, in order to strengthen national frameworks and take sharper decisions. This is the importance of UNESCO's Global Observatory of Science, Technology and Innovation Policy Instruments (GO→SPIN), which allows governments to review their country's performance against established indicators while exploring best practices from other countries. GO→SPIN provides key information on a range of levels, from STI policies, operational instruments and legal frameworks to STI national systems and data – all in order to improve policy-making, implementation and evaluation.

GO→SPIN is a core part of UNESCO's strategy to support the development of science policy initiatives, working with governments and other partners. Reliable information is vital for integrating research and innovation as cross-cutting policies into national development strategies and for catalysing greater investment by governments in the sciences for sustainable development.

I am confident that this new online series of country profiles by UNESCO will provide Member States and the global scientific community with a useful tool as we seek to build more inclusive knowledge societies.

Irina Bokova

Introduction

The growing complexity of science and innovation systems and the interface with society have been accompanied by a more complex policy environment. This results in a need for better co-ordination and coherence at national level. One of the most crucial factors is the increasingly global nature of the issues with which national policy-makers are confronted. In a whole series of areas, such as the environment, telecommunications, health, energy, education and intellectual property, it no longer makes much sense to construe problems in purely sectoral and national terms. In a world that is becoming daily more interdependent, policy-making is inevitably assuming an increasingly transversal and global dimension. In this context, science, technology and innovation (STI) policy systems have emerged as interconnections between knowledge, values, national and international socio-economic, environmental, technological and organizational components.

UNESCO has a long tradition of supporting Member States in policy development. With the convergence of S&T fields, the need to harness science, engineering, technology and innovation (SETI) for human and economic development and the transnational nature of today's challenges, STI policy processes have become a much more complex undertaking.

It is our vision that STI policies are transversal, cross-cutting policies that support and build the structural pillars for sustainable development. Therefore, UNESCO is conscious that monitoring and evaluating the impact of explicit and implicit policies and instruments is part of our work in supporting the design and implementation of STI frameworks in our Member States.

This second volume of the new online series of GO→SPIN Country Profiles in Science, Technology and Innovation Policy is dedicated to a study of the research and innovation landscape of the Republic of Zimbabwe. It is the second in a series of country profiles prepared by the Global Observatory of Science, Technology and Innovation Policy Instruments (GO→SPIN), a new UNESCO initiative.

The GO→SPIN programme is helping Member States to reform and upgrade national science systems and governance, and to build capacity to monitor and evaluate performance through SETI and social indicators. In this way, the scope of standard SETI assessment can be widened, to take into account country-specific contexts, as well as emerging knowledge of technological advances that contribute to sustainable development. Complementing efforts to promote evidence-based SETI policy-making, GO→SPIN offers a good basis for the promotion of scientific and technological foresight studies.

Through the GO→SPIN programme, UNESCO's Division of Science Policy and Capacity Building is working as a standard-setter, assisting in the elaboration of guidelines for SETI policy formulation, review and reforms, including monitoring and evaluation of policies and programmes. In this context, scientific advisory systems for governments and parliaments are necessary, as well as the availability of a wide range of scientific assessments to inform policy- and decision-makers and to bridge the gap between science and policy.

The Division of Science Policy and Capacity building has been collaborating with African Member States with the support of the Agencia Española de Cooperación Internacional para el Desarrollo (AECID) and its Spanish Fiduciary Fund allocated to the project, entitled Capacity Building in STI Policy in Africa.

After African countries expressed a common need to enhance capacities in the design and evaluation of SETI policies, policy instruments and governing bodies, three sub-regional workshops were organized by UNESCO between November 2012 and June 2013, in Harare (Zimbabwe), Dakar (Senegal) and Maputo (Mozambique). We applied the methodological approach developed by GO→SPIN to train higher national officials in designing, implementing and monitoring different types of operational policy instrument. This training involved officials from Angola, Botswana, Burkina Faso, Burundi, Cape Verde, Cote D'Ivoire, Gabon, Malawi, Mozambique, Niger, Senegal, Zambia and Zimbabwe. There are plans to extend this training to other sub-Saharan countries and Arab States.

In November 2012, during the African Ministerial Conference on Science and Technology (AMCOST V), it was recommended that the African Observatory on STI (AOSTI), the African STI Indicators Initiative (ASTII) and UNESCO's GO→SPIN programme improve co-ordination among their different surveys. Following this recommendation, an agreement between UNESCO and AOSTI was established in February 2013. The terms of this agreement place AOSTI in charge of following up each GO→SPIN survey for a group of West African countries. There are plans to extend this agreement to the entire continent.

The participating countries are currently completing a national GO→SPIN survey on SETI policies and policy instruments that will be part of both this new series of country profiles and the GO→SPIN online platform.

The present profile is based on the GO→SPIN survey prepared as follow-up to the Harare sub-regional training workshop by the officers of the Ministry of Higher and Tertiary Education, Science and Technology Development of the Republic of Zimbabwe.

Acknowledgments

Mapping Research and Innovation in the Republic of Zimbabwe is the outcome of a GO→SPIN training workshop organized by the Division of Science Policy and Capacity Building in Harare in 2012. Our sincere thanks go to the Government of Spain and the Spanish Agency for International Cooperation and Development (AECID) for their financial support and presence at this workshop. We would also like to express our gratitude to the senior officers of the Ministry of Higher and Tertiary Education, Science and Technology Development of the Republic of Zimbabwe who made this study possible: the Hon. Olivia N. Muchena (Minister), Hon. Godfrey Gandawa (Deputy Minister), Washington T. Mbizvo (Permanent Secretary) and the GO→SPIN survey team within the ministry's Department of Science and Technology: Rungano Karimanzira, Christopher C. Kateera and Beaula Chipoyera.

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Maciej Nalecz,
Director
Division of Science Policy and Capacity Building
UNESCO

The methodological framework for this series

GO→SPIN Country Profiles in Science, Technology and Innovation Policy is a series of reports published by UNESCO within its Global Observatory of Science, Technology and Innovation Policy Instruments (GO→SPIN). The GO→SPIN programme is run by UNESCO's Division of Science Policy and Capacity-Building.

The aim of this new series is to generate reliable, relevant information about the different landscapes of science, engineering, technology and innovation (SETI) policies around the world. The published information is based on replies to the GO→SPIN surveys, combined with government reports and statistical data from the UNESCO Institute for Statistics and other international sources.

Each country profile represents a comprehensive study of all the SETI policies, which include:

1. a long-term description of the political, economic, social, cultural and educational contextual factors;
2. a standard content analysis of the explicit SETI policies, including those research and innovation policies implemented in other sectors, such as the agricultural, energy, health, industrial and mining sectors;
3. a study of R&D and innovation indicators;
4. a long-term scientometric analysis of scientific publications, patents, trademarks and utility models;
5. a description of the SETI policy cycle;
6. a complete analysis of the SETI organizational chart at five different levels (policy-making level; promotion level; research and innovation execution level; scientific and technological services level and evaluation level);
7. an inventory of all the SETI government bodies and organizations related both to research and innovation and to science and technology services;
8. an inventory of the SETI legal framework, including acts, bills, regulations and international agreements on SETI issues;
9. a standard inventory with 18 different analytic dimensions of all the SETI operational policy instruments in place;
10. a SWOT analysis of the country's research and innovation landscape.

THE GO→SPIN APPROACH

The strategy of the GO→SPIN programme is four-fold:

- **Capacity-building:** training high-ranking national officials in the design, implementation and evaluation of a variety of SETI policy instruments at national and regional levels;
- **Standard-setter:** providing a standard practice for surveys on SETI policies and operational policy instruments through the *Paris Manual*[1]
- **Data collection:** worldwide distribution of the GO→SPIN surveys, prioritizing Africa, Arab States, Asia–Pacific and Latin American and the Caribbean.
- **GO→SPIN platform:** creation of an online, open access platform for decision-makers, knowledge-brokers, specialists and general public, with a complete set of various information on SETI policies.

The online platform will provide an innovative cluster of databases equipped with powerful graphic and analytical tools. The platform has been devized for political leaders, planners, directors and administrators of S&T in government, parliament, universities, research institutions, productive enterprises concerned with innovation, international organizations working for development; research personnel and specialists whose field of study embraces S&T policies.

1 The *Paris Manual* is being drafted by an international committee of experts put together by UNESCO in 2011. Once completed, the manual will define the ontological and epistemological bases of a common paradigm for evaluating STI policies and policy instruments worldwide.

The platform will also be a useful tool for the democratization of decision-making and public accountability of SETI policies.

The GO→SPIN survey and the information generated are primarily intended for the use of specialists and governmental bodies responsible for national SETI policies. It is their function to analyse the results of the survey and draw appropriate conclusions when they are required to prepare decisions by political bodies in the field of science, engineering, technology and innovation. The survey is also of interest to national bureaux of statistics and international organizations for promoting scientific and technological cooperation among their member states. Collectively, these users are:

- the national developing planning agencies, more particularly the government bodies responsible for formulating and co-ordinating national SETI policies and other national bodies involved in the application of science and technology (S&T) to sustainable development;
- parliamentary groups especially concerned with STI policies;
- SETI information brokers, consulting groups and advisory bodies;
- teaching and research departments engaged in SETI policy studies;
- The governing bodies of R&D institutes and S&T services;
- The boards of management of productive enterprises heavily reliant on R&D or engaged in the transfer of technology and innovation;
- International governmental and non-governmental organizations concerned with SETI and their application to sustainable development;
- Other more peripheral users, such as university departments of political science, economics and social sciences and national and international documentation and information services;
- The mass media.

At individual level, the main groupings are:

- **Decision-makers:** i.e. those responsible for national SETI policies and the management of R&D (ministries of R&D or S&T, directors of bodies responsible for formulating national S&T policies, directors of R&D institutes, heads of productive enterprises heavily reliant on R&D, etc.)
- **Intermediate users:** i.e. those who serve as the link between decision makers referred to above and researchers in S&T policy; their function is to prepare decisions by the former using theories and methods put forward by the latter, this category is made up of experts, consultants, advisers, liaison officers, the staff of ministerial offices and of parliamentary committees, etc., and they usually require rapid access to factual data.
- **Researchers in SETI policies:** i.e. those who develop the theories and methods on which S&T policy is based (researchers in the philosophy, history, sociology and economics of science, engineering and innovation, in the transfer of technology and in the management of R&D.
- **The general public:** by making SETI information more accessible, the GO→SPIN approach introduces a new dimension to the democratization of SETI.

THE METHODOLOGICAL FRAMEWORK

Science, engineering, technology and innovation (SETI) are becoming increasingly important for socio-economic and sustainable development. During the past 60 years, both developed and developing countries have recognized this fact by increasing the number of SETI government bodies, establishing new SETI legal frameworks and implementing a diverse set of new SETI policy instruments. This has driven investment in scientific research, technological development and innovation (STI), led to an increase in the number of scientists and engineers and fostered exponential growth in the number of new scientific articles and patents worldwide (UNESCO, 2010a).

The information economy is one of the key concepts invented to explain structural changes to the modern economy (Godin, 2008). The infrastructure to manage SETI information has been largely considered the core resource of national competitiveness in research and innovation (Neelameghan and Tocatlian, 1985). With the globalization of SETI information infrastructure has come a need to implement comprehensive strategies to connect, share and trade both domestic and foreign information at the national level (Lee and Kim, 2009).

The formulation of adequate SETI policies is critical to tackling contemporary challenges that include mitigating the consequences of global climate change; exploring new energy sources; generating innovation to foster social inclusion; promoting the sustainable management and conservation of freshwater, terrestrial resources and biodiversity; disaster resilience; and fostering the eradication of extreme poverty and hunger. These policies also need to be designed to achieve the UN Millennium Development Goals.

Over the past five decades, operational definitions have been elaborated within the framework of multilateral organizations to measure R&D and the broader concept of S&T. Statistical techniques have been developed to estimate private and public resources invested in these areas. For the former the OECD has laid down a methodological framework in the *Frascati Manual*, the sixth edition of which was published in 2002 (OECD, 2002). For the latter, the Member States of UNESCO have adopted the *Recommendations concerning the International Standardisation of Statistics on Science and Technology* (UNESCO, 1978; 1982; 1984a; 1984b). Methodologies for generating data about R&D investment and human resources have been constantly upgraded and extended.

During the first African Ministerial Conference on Science and Technology[2] (AMCOST I), in 2003, countries committed themselves to developing and adopting a common sets of STI indicators. The New Partnership for African Development (NEPAD) established the African Science, Technology and Innovation Indicators Initiative (ASTII) with the objective of building Africa's capacity to develop and use STI indicators. More specifically, NEPAD aims to: (a) develop and promote the adoption of internationally compatible STI indicators; (b) build human and institutional capacities for STI indicators and related surveys; (c) enable African countries to participate in international programmes on STI indicators; and (d) Inform African countries on the state of STI in Africa. The first *African Innovation Outlook* was published in 2011, while the second volume is being published in 2013. The methodology employed – that suggested by ASTII officials – follows the recommendations of the *Frascati Manual* for R&D indicators and the *Oslo Manual* (OECD, 2005) for innovation indicators.

In 2009, the UNESCO Institute for Statistics organized an Expert Meeting on Measuring R&D in Developing Countries, in Windhoek (Namibia). During the meeting, the experts identified the difficulties and challenges faced by the majority of developing countries, which were not explicitly addressed in the *Frascati Manual* (UNESCO Institute for Statistics, 2010; see Box A). The UNESCO Institute for Statistics is working towards a global standardization of STI statistics, including those items which are not taken into account in the *Frascati Manual*.

The availability of input and output R&D indicators alone does not suffice to evaluate SETI policies. Much more important than the particular value of one specific indicator at a given time is the long-term rate of change that long temporal series of indicators show (Lemarchand, 2010: 27–28). For that reason, long-term temporal series of indicators are necessary to analyse the impact of specific public policies. Improving the reliability of this analysis requires new ways of standardizing information about public policies and the policy instruments designed to implement them. Owing to the complexity of these issues, the 'science of science policy' has emerged in recent years as a new discipline where new analytic paradigms can be tested.

2 The final declaration of the AMCOST meeting in 2012 recommended coordination between the African Observatory on STI (AOSTI), ASTII and UNESCO's GOSPIN. An agreement between UNESCO and AOSTI in February 2013 assigned AOSTI with responsability for following up GO→SPIN surveys with a group of West African countries.

BOX A – MEASURING R&D: CHALLENGES FACED BY DEVELOPING COUNTRIES

The methodology for measuring R&D is detailed in the *Frascati Manual* (OECD, 2002), which has been in use for more than 50 years. A revised edition is due out in 2015. Despite the manual's longevity, developing countries still face problems when trying to apply its standards to measuring the situation in their particular country.

The UNESO Institute for Statistics conducts a biennial data collection of R&D statistics and produces a methodology tailored to the needs of developing countries; it also holds training workshops and builds capacity through other means in developing countries.

In 2014, the UNESCO Institute for Statistics published a *Guide to Conducting an R&D Survey: for Countries starting to Measure R&D*. This guide presents the relevant R&D indicators, discusses the main issues facing each of the major sectors of performance, provides a simple project management template and proposes generic model questionnaires for the government, higher education, business and private non-profit sectors which countries can use and adapt to suit their needs.

In 2010, the UNESCO Institute for Statistics produced a technical paper on *Measuring R&D: Challenges faced by Developing Countries*. The OECD Working Party of National Experts on Science and Technology Indicators (NESTI) subsequently suggested that the paper serve as the basis for an annex to the *Frascati Manual: Proposed Standard Practice for Surveys of Research and Experimental Development (6th edition)*. This annex was adopted as an online adjunct to the *Frascati Manual* in March 2012 (OECD, 2012).

Measuring R&D: Challenges faced by Developing Countries provides guidance on a number of challenges that are relevant to developing countries and which may not be elaborated on clearly enough in the *Frascati Manual*. The following situations are addressed in the document, among others:

- Despite the increasing presence of developing countries in global R&D, there is still a marked lack of demand for science, technology and innovation (STI) indicators from policy-makers in developing countries. Even if the demand does exist, there are often significant problems with compiling the data due to a lack of coordination at the national level, a lack of cooperation by research institutions, universities and businesses, and a generally weak statistical system in the country.
- R&D used to be largely funded by the government but new sources of funds are emerging. Foundations, scientific associations, NGOs and particularly foreign organizations already play an important role. In addition, the contribution of private business is becoming more important and gaining more recognition in a wider range of developing countries. Many of these new sources of funding go directly to individuals and groups rather than to institutions and therefore remain unaccounted for, including for statistical purposes.
- Although the *Frascati Manual* recommends the collection of primary data through direct surveys, the use of secondary data from national budgets and budgetary records of public R&D performing units has been a widely adopted practice to obtain a rough estimate of gross expenditure on R&D (GERD). However, there is often a discrepancy between voted and allocated budgets. Furthermore, national research systems have a limited absorption capacity, which may leave funds unused in central accounts instead of being transferred to institutions performing R&D. Moreover, care needs to be taken to ensure that such transfers are not 'double counted' as expenditure of both the funding body and the institution performing R&D.
- The definitions used by finance ministries and other government institutions to establish S&T budgets may be *ad hoc* and fail to distinguish between broad S&T and narrower R&D activities. Furthermore, many institutions (universities in particular) do not compile a separate R&D budget, especially where research is a low institutional priority.
- R&D components in the national budget, especially capital expenditure, can be difficult to identify and may be aggregated under different headings. In addition, when R&D activities

stretch over more than one financial year, it may not be easy to estimate the amount of resources used each year. For example, work done to develop land and buildings used for research in a given year should be clearly earmarked and not recorded in subsequent years.

- A concentration of innovation activities by sector or in a small set of institutes may lead to volatility and inconsistencies in statistics. There is generally lower emphasis on R&D in the business sector, in part due to reduced competitive pressure in local markets.
- In the higher education sector, the increasing number of private universities makes it useful to distinguish between public and private higher education and to further break up private higher education into government-dependent and independent private institutions. Further disaggregation into private-for-profit and private-not-for-profit higher education institutions should also be considered to track where most research is carried out.
- Surveys that cover all R&D performers should in principle all report for the same period. This is difficult to achieve since, in many countries, higher education institutions and businesses do not necessarily report on the same period – the business sector's calendar tends to be the most problematic. Also, not all countries follow the same calendar. As a solution, the recommendation that R&D performers report on the financial year closest to the survey period may have to suffice.
- Information systems in government and higher education are often not set up to enable the extraction of data on R&D personnel and expenditure. Thus, accurate information on financial expenditure only becomes available a long time after completion of an activity. Unfortunately, ad hoc IT solutions to address these issues may also lead to errors and inconsistencies.
- The collection of data in full-time equivalents (FTE) for researchers provides useful information on the true volume of human resources devoted to R&D. This information is also essential for estimating R&D labour costs. Tallying the number of researchers in a given country presents further challenges. In some developing countries, salaried researchers may not have research budgets or unpaid researchers may undertake research. In other scenarios, academic staff may hold part-time contracts at more than one university. Even if academic staff have contracts that specify the amount of time to be spent on conducting research, it is difficult to enforce especially where there is a lack of resources. Estimating the time spent on research and hence the calculation of the FTE for research staff – particularly in the higher education sector – is fraught with difficulties. This directly impacts the calculation of R&D expenditure.

A number of special types of activity warrant attention when measuring R&D, as they are rest on the border of what is considered R&D. Three examples follow from the technical paper:

- In the case of traditional knowledge, it is important to set boundaries. Activities which establish an interface between traditional knowledge and R&D are considered R&D. However, the storage and communication of traditional knowledge in traditional ways is excluded.
- Clinical trials are an area of growth in some developing countries. Identifying research personnel in the extended clinical trials value chain may be difficult, as their involvement is occasional and harbours a risk of double counting (i.e. as personnel in the trial and as academic staff).
- Reverse engineering is important in many developing countries. However, this generally falls outside the scope of R&D. Only if reverse engineering is carried out within the framework of an R&D project to develop a new (and different) product, should it be considered R&D.

STI statistical systems are often weak in developing countries. To help strengthen these systems, the paper recommends that countries institutionalise R&D statistics, establish registers of R&D performers and document survey procedures and estimations.

Countries interested in embarking on R&D measurement are encouraged to contact the UNESCO Institute for Statistics.

Better ways of measuring evidence-based policies

SETI policy debates are not yet dominated by a thoughtful, evidence-based analysis of the likely merits of different investment options and policy decisions. The latter are strongly influenced by past practice or data trends that may be out of date (Husbands Fealing *et al.*, 2011). The evolution of new policies has been accompanied by more difficult challenges related to planning and evaluating these policies (see Box B); this indicates a need to improve the theoretical frameworks for policy formulation (Steinmueller, 2010).

Unfortunately, a number of factors prevent countries from reaching most of the objectives established by their own development plans: the lack of reliable information on SETI national potentialities; difficulties in coordinating the various SETI stakeholders; an absence of mechanisms for promoting a strong interaction between the *supply* and *demand* sectors in SETI, and; the absence of any explicit industrialization policy promoting endogenous innovation.

These difficulties mostly appear in small economies. For example, Flanagan *et al.* (2011) have explored the ways in which innovation policy studies treat actors, instruments, institutions and interactions, in order to arrive at a more useful conceptualization of the policy mix for innovation. They stress the need for a genuinely dynamic view of policy formulation and policy interaction. They conclude that 'despite the importance attached to "strategic policy intelligence" in recent innovation policy analysis, little empirical attention has been devoted to actual processes of policy learning.' In developing and exploiting technological opportunities, institutional competencies – namely, the governance of SETI decision-making bodies – are just as important as the SETI incentive instruments they promote (Pavitt, 1996). Path dependency emerges, as the cost of institutional changes to SETI is often higher than that of accommodating new instruments and policies in existing structures (Van der Meulen, 1998). For this reason, the design, analysis and monitoring of any national SETI policy will strongly depend on the adequate mapping of: the structure of the SETI governing bodies; the SETI national legal framework and; of the implicit and explicit operational SETI policy instruments which are implemented (Herrera, 1971; 1972; Sagasti and Aráoz, 1976).

BOX B – THE POLICY-MAKING CYCLE

A stylized presentation of the policy-making cycle typically involves five stages:

- *Agenda-setting*: refers to the process by which problems related to SETI and the linkages between SETI and both society and the economy come to the government's attention;
- *Policy formulation:* refers to the process by which SETI policy options are formulated by the government;
- *Decision-making:* refers to the process by which governments adopt a particular course of action or non-action;
- *Policy Implementation:* refers to the process by which governments put SETI policies into effect and;
- *Policy evaluation:* refers to the process by which the results of SETI policies are monitored by both the State and societal actors. The result may be a re-conceptualization of policy problems and solutions, in which the effectiveness, efficiency and continuing appropriateness of policies and policy instruments are assessed and the results fed back into another round of agenda-setting.

Responsible and accountable SETI governance entails developing capabilities at each of these five stages.

WHY TALK ABOUT SETI POLICIES?

The term 'science policy' was coined following publication in 1945 of Vannevar Bush's seminal article *Science – the Endless Frontier*, which laid the foundations for the first social contract for science. By 1950, UNESCO had initiated the first systematic studies on science policies in a dozen developed countries. Originally, this term referred to public policies related to scientific and technological research, experimental development, scientific and technological services and innovation. *Science policy* as a discipline evolved over the coming decades. Today, it is possible to distinguish specific operational policy instruments according to the different needs established by science policies, engineering policies, technology policies and innovation policies. As these four distinct types of public policy require different skills, major universities around the world have recently introduced specific postgraduate programmes targeting each of the four types of policy:

S*cience policy:* relates to those policies needed to: promote scientific research, determine and select scientific objectives and goals consistent with national plans or strategies, exercise judgment in fixing norms to govern the ways and means by which science is developed, transferred and applied; gather, organize and deploy resources required to pursue the selective objectives and; monitor and evaluate the results obtained from applying the policy. The following are therefore among the most important questions dealt with by policy-makers in the field of science policy: (a) establishing and strengthening government structures and mechanisms for planning, budgeting, co-ordinating, managing and promoting scientific research; (b) gathering, processing and analysing basic data concerning the national scientific potential, including data on ongoing research, monitoring national scientific development and ensuring the smooth growth of the institutional infrastructure for scientific research; (c) maintaining a proper balance between the various types of research (fundamental, applied, experimental development), supporting the development of a creative national scientific community and setting standards for the status of scientific researchers in conformity with their responsibilities and rights; (d) optimizing human, financial, institutional and informational resources to achieve the objectives established by the national SETI policy; (e) assessing and promoting productivity, relevance, quality effectiveness of national research and scientific and technological services in various sectors of performance (higher education, government institutions, business enterprise, private non-profit) and removing organizational and managerial difficulties encountered in the execution of scientific research; (f) initiating appropriate legislative action in relation to the impact on the individual, society as a whole or the natural environment of the application of discoveries and inventions; evaluating the economic profitability and social utility (or harmful effects) of the said discoveries and inventions. Although the aforementioned list is not exhaustive, it indicates the key areas for which government policy-makers are primarily responsible. Each individual issue requires the design of a particular operational policy instrument.

E*ngineering policy:* the role of engineers in public policy can be seen as a two-fold endeavour: (1) to help create public policy related to the utilization of technology to solve public problems as well as monitor and ensure compliance with such policies; and (2) to use engineering knowledge to assist in the construction of policy directives to help solve social problems. In many cases, the development and implementation of such regulations and laws requires both a technical understanding of the functioning of these artefacts and an understanding of how this technology interacts with social and natural systems and would benefit from the involvement of a technical expert. The issues addressed by engineering policies are vast and global in nature and include water conservation, energy, transportation, communication, food production, habitat protection, disaster risk reduction, technology assessment and the deterioration of infrastructure systems. These issues need to be addressed while respecting the rights and meeting the needs and desires of a growing world population [for a detailed list of issues and challenges addressed by engineering policies, see UNESCO (2010c).

T*echnology policy:* the fundamental premise of technological policies is that it is possible for governments to implement public policies to improve social welfare by influencing the rate and direction of technological change. The conventional entry point for economic analysis is to identify the conditions needed for such influence to be superior to the outcome of ordinary market competition. These conditions, in turn, direct further examination of the feasibility and methods for such intervention, including the question of whether government intervention is necessary to improve social welfare. Succinctly stated, government intervention would be necessary if profit-seeking actors underperformed or performed poorly in producing or exchanging technological knowledge from the perspective of social welfare.

I*nnovation policy*: innovation policy can be characterized in various ways, such as by distinguishing between 'supply-side' and 'demand-side' policy, or between 'mission-oriented' and 'diffusion oriented' policy. Policy instruments include financial instruments (e.g. R&D tax credits, export incentives, soft loans, etc.) and regulatory instruments such as laws and binding regulations (e.g. the use of safety equipment for children in cars). Innovation policy encompasses many types of innovation. Innovation may be characterized, *inter alia*, by: the type of innovation – technological (product and process) or non-technological (organizational and marketing); the mode of innovation – novel innovator (strategic and intermittent), technology modifier and technology adopters and; the socio-economic impact – incremental, disruptive or radical. The effectiveness of innovation policies requires a sufficiently stable framework, institutions and policies. Stability and predictability are particularly important for risky activities with a long time horizon such as R&D and innovation. Excessive instability may inhibit innovation by increasing uncertainty for innovators. It may lessen the effectiveness of policy instruments by weakening the incentives they provide. In addition, it reduces opportunities for learning and developing evidence-based policy practices. Whereas there are manifold sources of unwarranted discontinuities, political instability and fiscal problems – often related to policy cycles – are a common cause. In an increasingly complex innovation landscape, developing effective governance requires better co-ordination at, and among, the local, regional, national and international levels.

SETI projects normally occur within a larger temporal framework administered by an organization or a government policy-making body. The early stages of a new SETI policy usually appear as successive expansions of the group of agents and stakeholders whose endorsement is needed to launch the initiative, whereas the latter stages focus on programme management, with feedback as to its success or failure at the policy level (Marburger III, 2011). Consequently, in order to provide an accurate landscape of the SETI policies and policy instruments in a specific national context, it is imperative to understand the long-term evolution of the SETI organizational chart, SETI infrastructure and legal framework (i.e. explicit policies), as well as the type of funding mechanisms implemented. The latter dimensions must be contrasted with detailed analyses of the long-term behaviour of political, educational, economic, productive and social macrovariables (i.e. implicit policies).

It is impossible to describe the current status of SETI without accurate data. Moreover, these data should be presented in such a way as to allow decision-makers and experts to estimate whether the status of SETI meets societal needs or expectations. Policy-makers benefit from additional policy tools to assist them in deciding about budget allocations or in the design of new SETI policy instruments, especially if these are real-time tools or new innovative prospective methodologies. Recent empirical studies show the relevance and long-term impact of appropriate SETI information services on SETI policies designed to improve national competitiveness (Lee and Kim, 2009).

It is also important to note the availability of a large group of public and private databases. These can be most useful tools for evaluating the performance of the SETI policies and providing adequate technology intelligence studies. There are robust, accessible systems designed to make rapid analyses and apply mathematical models to identify critical points or levers triggered by policy changes that can directly affect the performance of innovation activities. For example, Zucker and Darby (2011) present a comprehensive survey of all available databases that may be used to analyse the impact of SETI policies (see Box C).

BOX C – USING MATHEMATICAL THEORY TO PROMOTE STRATEGIC NATIONAL INNOVATION

Recent developments in the mathematical theory of networks can be applied to formulating new SETI policies, in order to promote strategic innovation within national economies.

Hidalgo *et al.* (2007) found that 'economies grow by upgrading the products they produce and export. The technology, capital, institutions and skills needed to make newer products are more easily adapted from some products than from others. The study of this network of relatedness between products, or 'product space,' shows that more-sophisticated products are located in a densely connected core, whereas less sophisticated products occupy a less connected periphery. Empirically, countries move through the product space by developing goods close to those they currently produce. Most countries can reach the core only by traversing empirically infrequent distances, which may help to explain why poor countries have trouble developing more competitive exports and fail to converge to the income levels of rich countries.'

This type of analysis can be applied directly to formulating customized SETI policy instruments to foster the development of specific technologies, where the country has detected a potential new technological niche. The availability of access to new electronic international databases (Zucker and Darby, 2011), combined with the appropriate analytic software, might transform this type of analysis into a standard procedure for selecting national SETI priorities.

Access to appropriate, reliable data is also a prerequisite for responsible and accountable governance, which demands informed decision-making at the planning stage of SETI policy and foresight as to the possible short and long-term impact of policy decisions. Therefore, policy-makers not only need a clear picture of the national, regional and global situation. They also need to be able to estimate the impact of current SETI policies and plan on future policies. The analysis of any national or regional SETI policy strongly depends on the adequate mapping of the structure of SETI governing bodies, SETI national legal frameworks and the implicit and explicit operational SETI policy instruments. Gaps or blind spots in information can cause a specific field to be neglected, which can result in missed opportunities for socio-economic development.

POLICY INSTRUMENTS: LEVERS FOR IMPLEMENTING DECISIONS

A policy may remain a mere rhetorical statement if no means are provided for its implementation or to realize its potential effect. To do this, a number of things may be needed, which we will incorporate under the term of policy instrument. A policy instrument constitutes the set of ways and means used when putting a given policy into practice. It can be considered as the vehicle through which those in charge of formulating and implementing policies actualize their capability to influence decisions taken by others.

The study of public policy instruments in national settings has contributed significantly to the understanding of policy, political systems and relations between State and citizen. Research on policy implementation usually focuses principally on the effects of a specific instrument, within a wider reflection on whether the correct instrument has been chosen for the purpose. As far as new governance models is concerned, the search for suitable instruments is above all governed by pragmatism (Kassim and Le Gales, 2010).

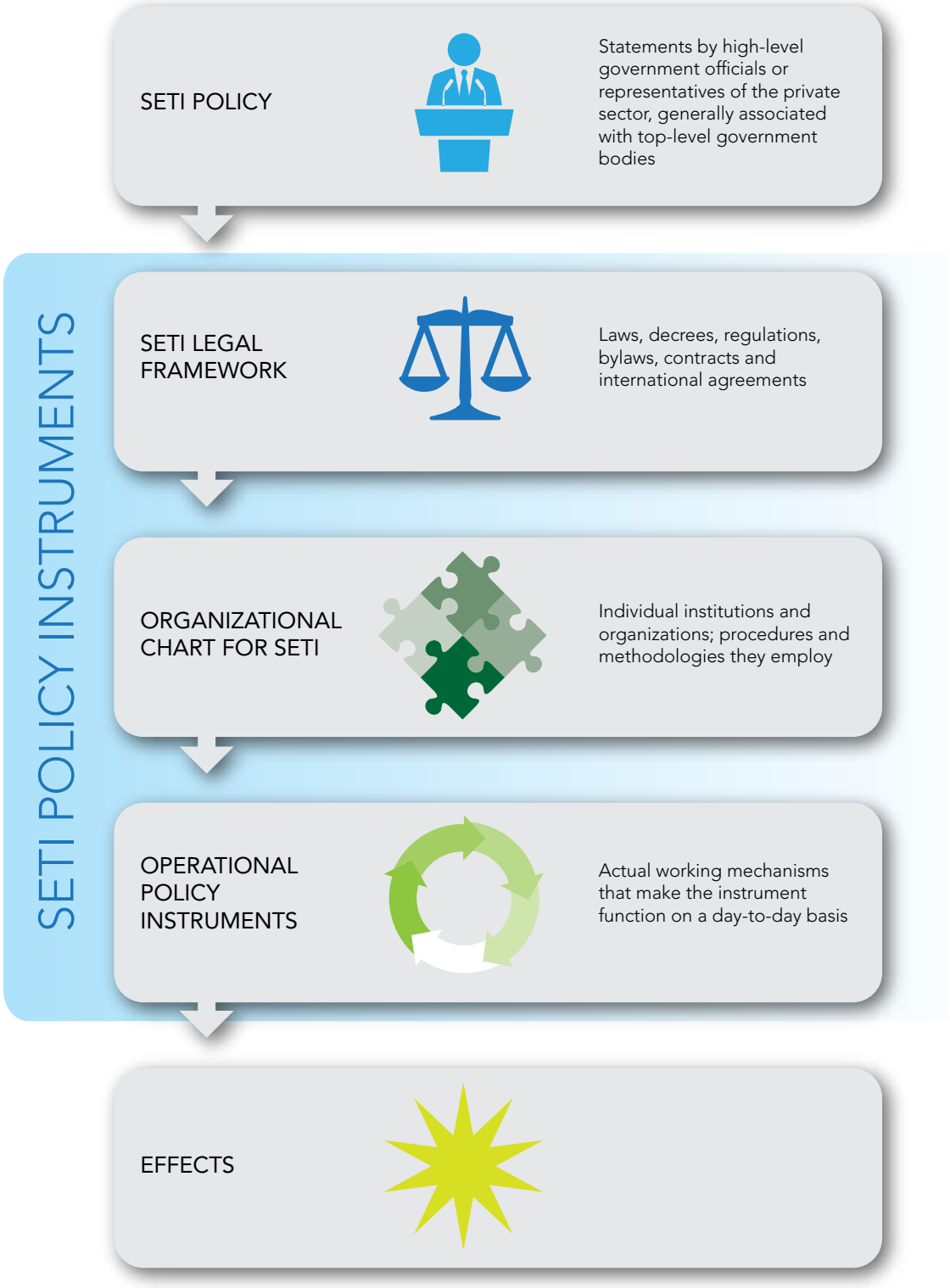


Figure A: Instruments for ensuring a policy obtains the desired effect. Adapted from Sagasti and Aráoz (1976)

SETI operational policy instruments are the levers by which the organizational structure ultimately implements the decisions on a day-to-day basis and attempts to produce the desired effect on the variables the policy has set out to influence. Throughout the analysis of an instrument's effectiveness, it is important to bear in mind the 'actors' or key decision-makers who are directly involved in the design and use of a policy instrument. An instrument does not act on its own accord. Rather, it responds to the will of the policy-makers and decision-makers using it.

A related concept can be found in the problem of *Ordnungspolitik* stressed by the German Freiburg School in the 1930s. Here, the focus was how to devise a framework or set of rules (*Ordnungsrahmen*) for an economy that would define the operating space for individual and private activities. The challenge for SETI policy instruments can be interpreted as a problem of transformation, namely the question of choosing the best policy instrument in order to reach the set target.

A policy instrument attempts to make individuals and institutions take decisions following the rationality dictated by the collective objectives established by those in power. It is the connecting link between the purpose expressed in a policy and the effect that is sought in practice. An SETI policy instrument includes, as a significant component, the manipulation of SETI variables.

One of the first and more relevant studies on SETI policy instruments was conducted in the 1970s by the International Development Research Centre. The principal objective of the study was to devise ways and means of understanding how a country's investment in S&T could be most effectively related to its objectives for industrial development. Sagasti and Aráoz (1976) developed an interesting methodological framework for making a survey and analysing the policy instruments of ten countries in Latin America, the Middle East, Southern Europe and Asia.

UNESCO's Global Observatory of Science, Technology and Innovation Policy Instruments[3] (GO→SPIN) has adapted and expanded the theoretical framework of Sagasti and Aráoz (1976), in order to implement a systematic survey in Africa, Arab States, Asia and the Pacific and in Latin America and the Caribbean. The information in the present country profile has been organized according to this methodological approach. Figure A presents the basic analytical units around which the present report is organized.

All national SETI policies, be they *implicit* or *explicit* (Herrera, 1971; 1972), attempt to harness a country's creative potential to its socio-economic, environmental and cultural objectives. An *explicit* SETI policy is a statement by a high-level government official or institution, such as a ministry or the planning secretariat, that deals with activities related to STI. The policy expresses a purpose (effects according to SETI variables) and may set objectives, define desired outcomes and establish quantitative goals. Policies also contain criteria for choosing from among several alternatives to guide decision-makers as to how SETI works. SETI policies might also be formulated by representatives of the private sector. A number of factors impinge on the efficiency of SETI governance, namely, the extent to which policy processes have the greatest effect with a given use of resources. It must be acknowledged that overall efficiency is not easily defined and measured in a multi-objective, multi-actor world.

3 See www.unesco.org/new/en/natural-sciences/science-technology/sti-policy/global-observatory-on-policy-instruments

THE KEY ROLE OF THE SETI ORGANIZATIONAL STRUCTURE IN POLICY IMPLEMENTATION

The SETI organizational structure or chart usually shows the distribution of responsibility for implementing a given policy. Under the term 'organizational structure,' it is possible to distinguish at least five different levels: (1) policy planning level (policy design); (2) promotional level (i.e. funding and co-ordination of R&D, innovation and scientific and technological services); (3) implementation level (execution of R&D and innovation); (4) scientific and technological services and; (5) assessment or evaluation level.

1. *Policy planning level*: includes policy planning, budgeting, decision-making, interministerial co-ordination. The responsibility for the formulation of SETI policies generally rests with a special government department, ministry or statutory body, in some cases assisted by national councils of research and innovation. SETI policy formulation normally includes the preparation of the national development plan or strategy relating to SETI; it also includes the annual preparation of the functional state budget for SETI activities (mainly research, innovation and scientific and technological services). The decision-making function usually falls to the government, or to a committee of ministers more specifically concerned with SETI; it mainly involves the approval of the national SETI plan (or strategy), as well as the assignment of funding mechanisms. The interministerial co-ordination takes place during the formulation of policies and preparation of plans and budgets then at the various stages of the implementation of these policy documents, once approved by the government.
2. *Promotional level*: the promotion, financing and co-ordination of research, innovation and scientific and technological services in the various sectors of the economy and in society. The functions performed at this level begin with the policy decisions taken by the government and continue with the various government departments or ministries through traditional budgetary procedures along administrative budget lines or through programme budget procedures, as applied to the so-called management by objectives. Several funding mechanisms and SETI operational policy instruments of various kinds have been implemented over the years (i.e. research funds, innovation funds, sectorial funds, tax-incentives; competitive grants, scholarships, etc.). Most countries apply a combination of operational policy instruments to handle the financing of research, innovation and scientific and technological services according to well-defined programmes. The latter can be achieved either by responding to requests for the funding of specific projects submitted by external institutions, laboratories, research units, individual research scientists and high-tech enterprises, or by providing incentives for innovation, or by selectively entrusting the external bodies mentioned above with the execution of specific projects called for by certain development objectives according to the national SETI plan or strategy (normative method). At this particular level, several countries have special institutions (i.e. national research councils) which promote the advancement of scientific research and technological development with a view to improving the quantity and quality of new scientific knowledge to expand the country's potentialities, particularly through support for post-graduate education and research at universities and polytechnics.
3. *Implementation level*: this operational level concerns the actual performance of scientific research, technological development and innovation.
4. *Scientific and technological services (STS) level*: this represents a mixed group, including the institutions in charge of: (a) SETI information and documentation, (b) museums of science and technology, botanical and zoological parks and other SETI collections (anthropological, archaeological, geological, etc.), (c) general purpose data collections: all the activities comprising the routine systematic collection of data in all fields of SETI, such as topographical, geological and hydrological surveys, routine astronomical, meteorological and seismological observations, surveying of soils and plants, fish and wildlife resources, atmosphere and water testing, monitoring of radioactivity, UV and CO_2 levels, prospecting and related activities designed to locate and identify oil and mineral resources, gathering of information on human, social, economic and cultural phenomena, usually for the purpose of compiling routine statistics; testing, standardization, metrology and quality control, activities related to patents and licenses, as well as the production of scientific publications.

5. *Assessment or evaluation level*: this consists in government sectors and institutions monitoring the implementation of policy goals and measuring the societal impact of those policies. Their function also encompasses the conduct of an ongoing survey of a country's SETI potential at the level of research, innovation and scientific and technological service units, including ongoing research results and their practical application.

The GO→SPIN methodological approach introduced a normalized way of encoding the different types of organization and their functions. By representing each national SETI organizational chart and by using the same set of coding tools (Lemarchand, 2010: 310), it will be possible in future to associate these charts and tools with specific topological metrics to identify patterns in performance. The latter will be very useful for defining a new set of SETI policy indicators able to reveal the level of complexity and functionality of each STI organizational chart. Table A shows a typical example on how different countries structure SETI policy design.

Since its purpose is to guide decisions about the future that must be taken now, a SETI watch cannot seek to identify future developments in S&T independently of past and current developments, or independently of the material and human resources devoted to research and innovation. The prerequisites for any future is: knowledge of the present, knowledge of the current trends observed in a real world composed of different nations and institutions and knowledge of the strength and weaknesses of the national SETI system in which the decisions informed by the GO→SPIN survey methodological approach have to be taken.

Table A: Models of governing bodies heading SETI policy design

Argentina	Scientific and Technological Cabinet (GACTEC) Ministry of Science, Technology and Productive Innovation
Australia	Prime Minister's Science Engineering and Innovation Council Commonwealth State and Territory Advisory Council on Innovation Coordination Committee on Innovation
Chile	Inter-ministerial Committee for Innovation National Corporation for the Promotion of Production (Ministry of Economy) National Commission for Scientific and Technological Research (Ministry of Education)
Croatia	Ministry of Science, Education and Sports National Council for Science National Council for Higher Education
Czech Republic	Ministry of Industry and Trade Council for Research, Development and Innovation Ministry of Education, Youth and Sports
Finland	Research and Innovation Council Ministry of Employment and the Economy Ministry of Education and Culture
Ireland	Inter-Departmental Committee on STI Department of Jobs, Enterprise and Innovation
Malaysia	Ministry of International Trade and Industry Ministry of Science, Technology and Innovation Economic Planning Unit
Republic of Korea	National Science and Technology Council Ministry of Science and Technology
Singapore	Economic Development Board Research, Innovation and Enterprise Council National Research Foundation
South Africa	Department of Science and Technology Department of Trade and Industry Department of Higher Education and Training

Source: UNESCO

The diversity of institutions at the promotion level (funding) in a given country seems to be one of the most fundamental indicators of good practices. The GO→SPIN global database will provide empirical evidence to confirm or refute this and other hypotheses.

The so-called *legal framework* can also be considered as a legal instrument. This embodies the policy, or parts thereof, in the form of a law, decree or regulation. Formal agreements, contracts and international STI cooperation treaties may also be included in this category. A legal instrument goes one step beyond a policy by stipulating obligations, rights, rewards and penalties. The GO→SPIN systemic approach has developed a friendly platform offering direct access to the entire SETI legal framework, description and the full text of laws, acts, decrees and agreements adopted by each country. Table B shows different examples of the most important types of legal instrument.

Table B: Examples of SETI legal instruments

A law for the creation of national research labs, universities, national research councils, ministry of S&T, R&D Funds, etc., or a legal framework to regulate the organization of the national innovation system.
A law to regulate the imports/exports of high-tech products.
A law to regulate tax incentives to promote innovation within the private sector.
A law to regulate foreign direct investments promoting the establishment of new high-tech enterprises.
A law to regulate the protection of the national biodiversity and to establish norms on how foreign companies exploit the active substances available within each national territory (new rules for the protection of indigenous knowledge).
Laws to foster R&D activities within the private sector and the creation of technological funds associated with the most strategic sectors of the economy (energy, mining, agriculture, industry, communication, fishing, tourism, etc.).
National regulations and decrees to establish new national policies, creation of new funding mechanisms, import/export tariffs, etc.
Bilateral, regional and international agreements on SETI activities.
Contracts on technology transfer.

Source: UNESCO

GO→SPIN also includes a complete description of SETI operational policy instruments; these are the levers, or actual means, through which the organizational structure ultimately implements the decisions on a day to day basis and attempts to influence the behaviour of the various stakeholders targeted by the policy. Throughout the analysis of an instrument, it is important to keep in mind the actors or key decision-makers who are directly involved in the design and use of a policy instrument. An instrument does not act on its own accord. Rather, it responds to the will of the policy-makers and decision-makers using it. Table C shows different types of operational policy instrument, whereas Figure B shows various instruments that can be employed to effect at the different stages leading to market penetration of an innovation. Table D presents the taxonomic classification of SETI operational policy instruments employed by GO→SPIN according to its methodological approach, by objective and goal; the type of mechanism/mode of support and target groups/beneficiaries. By analysing the aggregated information for groups of countries employing these classification schemes, it is possible to detect development patterns.

Table C: Examples of operational SETI policy instruments

Programmes and objectives	Policy instrument	Strategic objectives	Beneficiaries	Mechanisms for allocating funding
Scientific research and technological development	Competitive grants	Promote the endogenous production of new scientific knowledge in the exact and natural sciences. Promote regional networking.	Research groups at national universities and national research centres associated with similar research groups from other countries in the region, within formal partnership agreements	Competitive grants selected on a peer review basis; national research groups must be associated with similar groups from countries in the region which provide matching funding
Promotion of science education	Public subsidies for projects establishing science laboratories at public secondary schools	Improve scientific knowledge; methodological approach and critical thinking for secondary school pupils	Public secondary schools in less developed parts of the country	Public subsidies to mount new science cabinets and laboratories and new posts for science professors
Promotion of gender equality in research and innovation	Scholarships	Promote the participation of women in high-tech research and innovation	Young women enrolled in a PhD programme in basic and engineering sciences	Scholarships of up to four years and small grants for participation in international conferences
Protection of indigenous knowledge	Intellectual property rights, public law–national legislation and public subsidies	Protection of traditional knowledge to confer exclusive ownership and rights on local communities when the object of protection is a product or domesticated animal, cultivated plant or any micro-organism, or a design or an object of a functional or aesthetic nature, including any element of handicrafts, the act prohibits third parties from making, using, stocking, offering for sale, selling, commercializing, importing, exporting or identifying the active substances for commercialization, without consent	A local traditional practitioner, a local community or its representative may apply to register traditional knowledge	Public subsidies and tax exemptions to defend the Intellectual property rights of holders of indigenous and traditional knowledge
Attraction and reinvestment of foreign direct investment	Public financing Tax incentives	Strategies vary from country to country, examples being: (a) an Industrial policy based on attracting export-oriented industries; (b) promotion of structural change; (c) capacity-building to improve competitiveness, focusing on sectors or market niches; (d) internationalization of enterprises, and promotion of innovation; (e) prioritizing the generation of higher-tech goods and services (f) attracting selective FDI oriented towards ICTs, biotechnology, nanotechnology and financial services; (g) improving the business climate by refining legislation and simplifying formalities to facilitate corporate operations.	National Infrastructure (buildings, technology corridors, technological cities) and training of labour and professionals for the industry in question SMEs with export capacity	Soft-loans, tax incentives, grants For specific periods: tax discounts, exemptions, preferential rates, rebates on machinery and equipment
	Attracting R&D firms		Endogenous entrepreneurs High-tech emerging sectors: biotechnology, nanotechnology, new materials, ICTs.	The same tax incentives plus special competitive funding
	Other services	Structural change within a large country offers more opportunities for the domestic market, small and medium-sized countries generally focus on schemes conducive to the development of exports	Strengthening exports of industries and services considered to have strong potential in the country	Creation of a "one-stop shop" with representatives from different ministries/ agencies to deal with problems concerning programmes, public regulations and post-investment services

Programmes and objectives	Policy instrument	Strategic objectives	Beneficiaries	Mechanisms for allocating funding
Technological development	Non-repayable contributions	Increased competitiveness through innovation in products, services and processes	Micro-, small and medium-sized enterprises and broader enterprises certified as having attained international standards	By public competition; up to 50% of project cost
	Loans for technological development projects	Finance for middle-income technology production projects	Micro-, small and medium-sized enterprises with R&D departments or teams, collaborating groups and technical linkage units underwritten by the enterprise	Compulsorily repayable loans; up to 80% of the total cost, allocated on an open window basis, with a maximum of $... for three years
Technological modernization (improvement of products and processes, training)	Fiscal credit programme	Assistance in executing R&D	Physical or juridical persons who own enterprises producing goods and services	Subsidies through fiscal credit certificates obtained via public competition; up to 50% of the total cost of the project
	Loans for modernization Projects	Technological adaptation and improvements to products and processes with a low level of technical and economic risk	Enterprises with R&D department or groups; collaboration groups, and technical linkage units underwritten by the enterprise	Special compulsorily repayable loans allocated on an open window basis. Up to 80% of the total cost of the project, with a maximum of $...in three years
	Loans to enterprises	To finance projects for the development of new production processes, products and modifications thereto	Enterprises, without any restriction on size or sector; no finance provided for projects with a rate of return of less than 12%	Compulsorily repayable loans allocated on an open window basis. Up to 80% of the total cost of the project, with a maximum of $...
Promotion of the technological services market (research institutes and business research centres)	Subsidies for projects to develop business plans	Finance for business development projects based on R&D	Micro-, small and medium-sized enterprises whose projects are executed by technical linkage units	Subsidies allocated on an open window basis. Up to 50% of the total project cost, with a maximum of $..., for up to one year
	Loans to institutions	To promote the establishment and strengthening of structures for the provision of technological services to R&D enterprises and institutions	Public or private institutions providing services to the private productive sector; projects may be presented on an individual or associated basis	Obligatorily repayable subsidies allocated on an open window basis, up to a maximum of $...
Training and technical assistance	Subsidies for training and retraining projects	Subsidies to support activities for training and retraining human resources in new technologies	Micro-, small and medium-sized enterprises whose projects are executed by technical linkage units	Subsidies allocated on an open window basis. Up to a maximum of 50% of the total cost of the project, or $... for up to six months
	Subsidies for project Formulation	Support for the formulation of R&D projects, technology transfer or technical assistance	Micro-, small and medium-sized enterprises whose projects are executed by technical linkage units	Subsidies allocated on an open window basis. Up to a maximum of 50% of the total cost of the project, or $... for up to six months
Technological advisory assistance programmes and those strengthening the performance of technical small and medium-sized enterprises	Technological advisory assistance programme	Support for the formulation of R&D projects, technology transfer or technical assistance	Micro-, small and medium-sized enterprises producing goods and services which incorporate technological added value	Subsidies allocated on an open window basis to individuals or groups, with a maximum of 50% of the total cost of the project, or $... and a maximum of $... per participating enterprise
Popularization and social appropriation of science	Competitive grants	Support for the organization of national exhibitions and science fairs	Science museums, educational institutions at primary, secondary and tertiary levels	Subsidies allocated on a competitive basis

Source: UNESCO, UN ECLAC, FONTAR (Argentina)

Different operational policy instruments for different stages of the innovation process

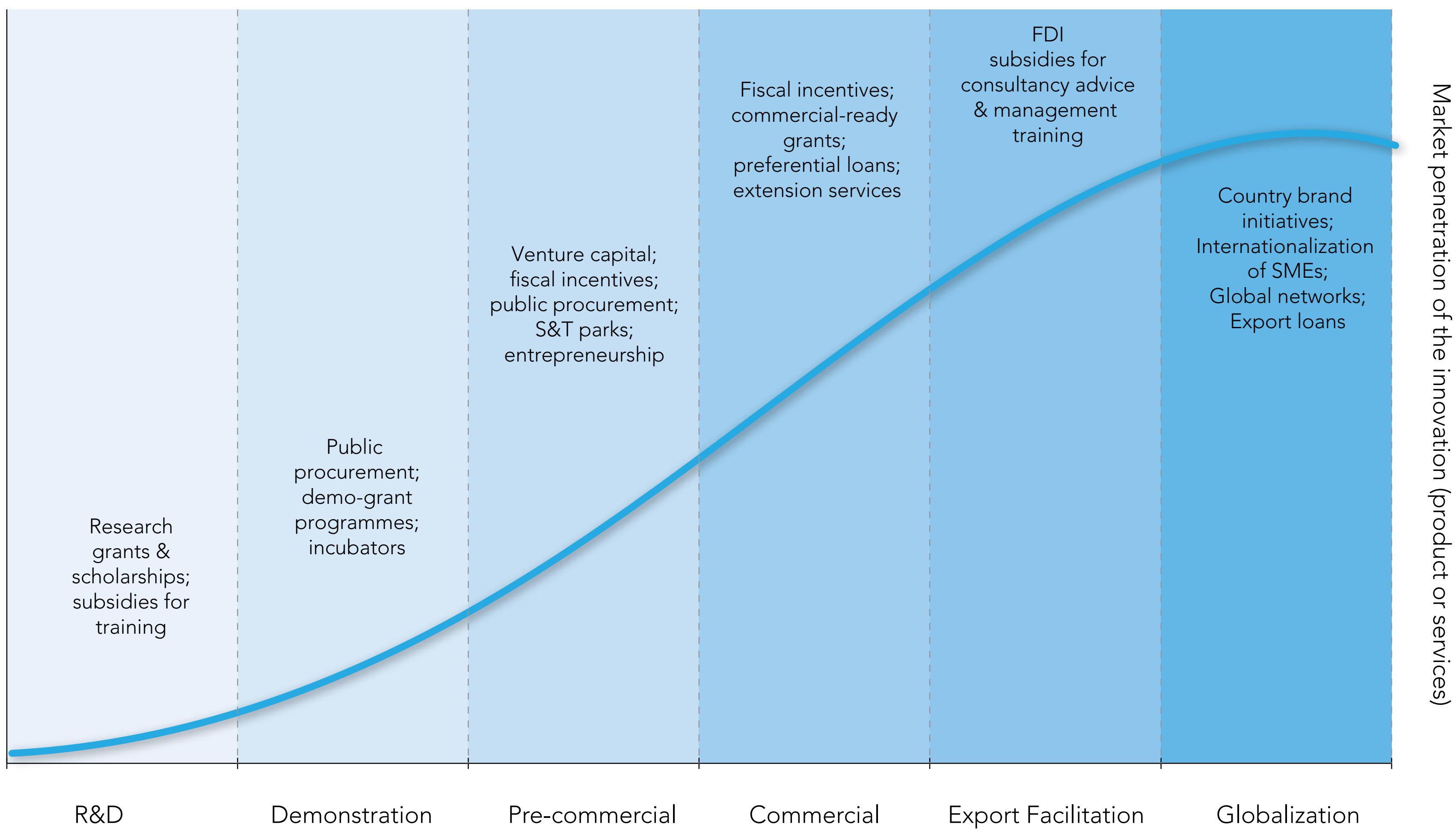


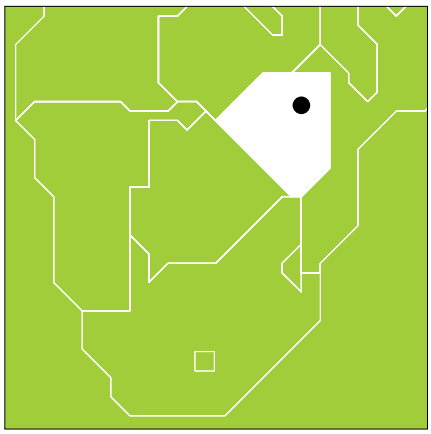
Figure B: Policy instruments for different stages of the innovation process and market penetration.
Source: UNESCO

Table D: Taxonomic classification of SETI operational policy instruments employed by GO→SPIN

Objectives and goals	Type of mechanism/ Mode of support	Target groups/Beneficiaries
Strengthen the production of new endogenous scientific knowledge	Grants (grant funds)	Technical and support staff at SETI
Strengthen the infrastructure of research laboratories in the public and private sectors	Donations (individuals/ companies)	Students
Human resources for research, innovation and strategic planning; capacity building, education and training of specialized human capital for (1) the production of new scientific knowledge, (2) development of new technologies, (3) promotion of innovation within the productive and services systems and (4) management of the knowledge society	Loans	Individual professionals / PhD holders
Strengthen gender equality for research and innovation	Creation of, and support for, technological poles and centres of excellence	Teachers/ Researchers
Strengthen the social appropriation of scientific knowledge and new technologies	Tax incentives	Universities
Development of strategic technological areas and new niche products and services with high added value; promotion and development of innovation in the production of goods and services; promotion of start-ups in areas of high technology	Technical assistance	Research centres
Strengthen science education programmes at all levels (from primary school to postgraduate)	Scholarships	Technical training centres
Promotion of the development of green technologies and social-inclusion technologies	Credit incentives and venture capital	Schools/ Colleges/ Institutes
Promotion of indigenous knowledge systems	Trust funds	Corporations/ Foundations
Research and innovation eco-system: strengthening co-ordination, networking and integration processes which promote synergies among the different actors of the national scientific, technological and productive innovation system (i.e. government, university and productive sectors)	Information services	Professional Institutes
Strengthen the quality of technology foresight studies to: assess the potential of high-value markets; develop business plans for high-tech companies; construct and analyse long-term scenarios and; provide consulting services and strategic intelligence	Others	SETI local groups (e.g. a group of independent researchers)
Strengthen regional and international co-operation, networking and promotion of SETI activities		Private companies
		Science and technology public or private non-profit organizations
		Ad hoc associations
		Individuals
		Small and medium-sized enterprises
		Public institutions
		Co-operatives
		Other

Source: UNESCO

Zimbabwe: mapping the landscape of a small-economy innovation system



OFFICIAL NAME: Republic of Zimbabwe (formerly Southern Rhodesia then Rhodesia)

ABBREVIATION: ZW

CAPITAL CITY: Harare

HEAD OF STATE AND HEAD OF GOVERNMENT: His Excellency Robert Gabriel Mugabe

NATURE OF GOVERNMENT: Parliamentary democracy

POPULATION[1]: 13 771 721 (July 2014 estimate)

SURFACE AREA: 390 757 km^2

ETHNIC GROUPS: African 98% (Shona 82%, Ndebele 14%, other 2%), mixed and Asian 1%, Caucasians, less than 1%.

LANGUAGES: English (official), Kalanga, Shona, Ndebele, Venda, Tonga

RELIGIONS: Multi-religious (predominantly Christianity, Traditional and Islam)

UNIT OF CURRENCY: Multi-currency (mainly United States Dollar, South African Rand)

DATE OF INDEPENDENCE: 18 April 1980

DATE OF CONSTITUTION: previous, 1979; latest, approved by referendum on 16 March 2013 and by Parliament on 9 May 2013.

HISTORY OF A PEOPLE

The history of Zimbabwe can be traced back 100 000 years. Anthropological studies provide evidence of Stone Age cultures that include the San people, whose descendants now live mostly in the Kalahari Desert. It is thought that the San are the descendants of Zimbabwe's original inhabitants (Gall, 2004). The remains of ironworking cultures that date back to AD 300 have been discovered. Little is known of the early ironworkers but it is believed that they were farmers, herdsmen and hunters who lived in small groups. They put pressure on the San by gradually taking over the land. With the arrival of the Bantu-speaking Shona from the north between the 10th and 11th centuries AD, the San were driven out or killed and the early ironworkers were incorporated into the invading groups.

The Shona gradually developed a gold and ivory trade with the coast and, by the mid-15th century, had established a strong empire, with the ancient city of Great Zimbabwe as its capital (Bessire, 1999). The name of Zimbabwe is derived from the Shona term of *dzimba dzemabwe*, meaning houses of stone or stone buildings. Archaeologists believe the construction of Great Zimbabwe may have taken 400 years (Beck *et al.*, 2009). This majestic ancient stone city flourished near the modern town of Masvingo from about 1290 to 1450, buoyed by a powerful and organized society. It thrived, thanks to favourable agricultural conditions, cattle-raising, great mineral wealth and, most significantly, both regional and long-distance trade. Trade was conducted with such far-flung places as China, India, the Middle East and the Near East, East and West Africa, among others. By the end of the 15th century, the empire, known as Munhumutapa, had split, with the southern part becoming the Urozwi Empire, which flourished for another two centuries.

Pre-colonial Zimbabwe was a multi-ethnic society inhabited by the Shangani and Tsonga in the south-eastern parts of the Zimbabwe plateau, the Venda in the south, the Tonga in the north, the Kalanga and Ndebele in the south-west, the Karanga in the southern parts of the plateau, the Zezuru and Korekore in the northern and central parts and, lastly, the Manyika and Ndau in the east. Scholars have tended to lump these various groups into two huge ethnic blocs, namely, the Ndebele and Shona, largely because

1 Estimate by UN Statistics Division; estimates for Zimbabwe explicitly take into account the effects of excess mortality due to AIDS; this can result in lower life expectancy, higher infant mortality, higher death rates, lower population growth rates and more changes in the distribution of population by age and sex than would otherwise be expected.

of their broadly similar languages, beliefs and institutions. The political, social and economic relations of these groups were complex, dynamic, fluid and always changing. They were characterized by both conflict and co-operation.

From the 1880s to the early 20th century, a coalescence of Christianity, mercantilism, colonialism and capitalism gradually displaced the pre-colonial socio-political and economic formations discussed above, bringing about a colonial transformation marked by the emergence of new identities, new commodities, new languages, new ideologies, new relationships, new political and economic outlooks and new tastes.

In 1888, Lobengula, king of the Ndebele, accepted a treaty with Great Britain and granted Charles Rudd, an agent of English businessman Cecil Rhodes, exclusive mineral rights to the lands he controlled. Gold was already known to exist in Mashonaland, so, with the granting of these rights, Rhodes was able to obtain a royal charter for his new British South Africa Company (BSAC) in 1889. The BSAC sent a group of settlers with a force of European police into Mashonaland, where they founded the town of Salisbury (now Harare). Rhodes gained the right to dispose of land to settlers (a right he was already exercising *de facto*), marking the beginning of white settler occupation of Zimbabwe. With the defeat of the Ndebele and the Shona between 1893 and 1897, Europeans were guaranteed unimpeded settlement.

The name Rhodesia was in common usage by 1895. In 1898, the British officially recognized the name of Rhodesia for the colony, after promulgating the Rhodesia Order in Council. The Order in Council was the governing instrument of Rhodesia until 1923 when the settlers were accorded Responsible Government and Southern Rhodesia was annexed to the British crown; its African inhabitants thereby became British subjects and the colony received its basic constitution.

A significant characteristic of early colonial rule in Zimbabwe was land dispossession and forcible proletarianization of the African. Two key settler aims were maximum output premised on minimum cost. These twin goals could only be achieved by: restricting African access to land, thus undercutting African peasant agricultural production, and: increasing taxation and, hence, forcing Africans to sell their labour cheaply to white mine owners and farmers.

In 1953, the Central African Federation was formed, consisting of the three British territories of Northern Rhodesia (now Zambia), Nyasaland (now Malawi) and Southern Rhodesia (now Zimbabwe), with each territory retaining its original constitutional status. In 1962, Nyasaland and Northern Rhodesia withdrew from the federation with British approval. The federation disbanded in 1963, Southern Rhodesia, although legally still a colony, seeking an independent course under the name of Rhodesia.

Political agitation in Rhodesia increased after the United Kingdom's granting of independence to Malawi and Zambia. The white settler government demanded formalization of independence, which it claimed had been in effect since 1923. The African nationalists also demanded independence but under conditions of universal franchise and African majority rule. Negotiations repeatedly broke down and, in November 1965, the Rhodesian government issued a Unilateral Declaration of Independence (since known as UDI). The day after the UDI was issued, the United Nations Security Council passed a resolution calling upon all states not to recognize Rhodesia and imposing a series of mandatory economic sanctions.

The civil war/liberation struggle that engulfed Rhodesia between 1964 and 1979 was complex. The crisis escalated as regional and international political pressure grew and opposition to white rule became increasingly militant. A guerrilla conflict developed between the government and two of the principal African nationalist groups, the Zimbabwe African People's Union (ZAPU) and the Zimbabwe African National Union (ZANU). Members of a third group, the United African National Council (UANC), were increasingly subjected to persecution and arrest. Nevertheless, guerrilla activity continued. Pressure from the Organization of African Unity (OAU) led to the formation of the Patriotic Front in the mid-1970s by ZANU, led by Robert Mugabe, and ZAPU, led by Joshua Nkomo. The OAU's official recognition of the liberation movement and its leadership conferred legitimacy on the Patriotic Front. The Patriotic Front intensified the armed struggle, with ZAPU operating from Zambia and ZANU from Mozambique (UNESCO, 1993).

The final phase of the war was littered with atrocities that culminated in all parties agreeing to a peaceful settlement at the Lancaster House Conference in 1979; this, in turn, resulted in the February 1980 general election that ultimately led to independence on 18 April 1980. The Lancaster House Agreement established a Parliament of 80 Africans and 20 whites. In the 1980 election, the ZANU-Patriotic Front won 57 seats, ZAPU 20 seats and the UANC the remaining three seats (UNESCO, 1993).

Following independence, Zimbabwe initially made significant social and economic progress. The country is currently showing signs of recovery from a chronic economic crisis which peaked in 2008–2009. See pages 11 and 30 for details.

The Constitution of Zimbabwe is officially the supreme law of the country. The constitution of 1979 resulted from the Lancaster House Agreement and is sometimes called the Lancaster Constitution. A proposed new constitution, drafted by a constitutional convention, was defeated by a constitutional referendum in 2000.

Robert Mugabe has been President of Zimbabwe since 1987. He leads the ZANU-PF party. In 2008, he concluded a power-sharing deal with the Movement of Democratic Change–Tsvangirai (MDC-T) and Movement of Democratic Change-Ncube (MDC-N). On 11 February 2009, Morgan Tsvangirai was sworn in as Prime Minister by President Mugabe. The three main political parties negotiated a new constitution, following a constitutional outreach programme. The new constitution was approved by referendum on 16 March 2013 then by Parliament on 9 May 2013.

The Republic of Zimbabwe is a presidential republic, whereby the president is the Head of State and Government. Executive power is exercised by the government. Legislative power is vested in both the government and Parliament. The judiciary, headed by the Chief Justice of the Supreme Court of Zimbabwe, is the third arm of government. Zimbabwe holds harmonized elections every five years. The most recent elections on 31 July 2013 ushered in a new government.

DEMOGRAPHIC PROFILE

Africans make up 98% of Zimbabwe's population and are mainly related to the two major Bantu-speaking groups, the Shona (about 82% of the population) and Ndebele (about 14%). Of the former group, the Korekore predominate in the north, the Zezuru in the centre around Harare, the Karanga in the south, the Ndau and Manyika in the east and the Kalanga in the west; the Rozwi are spread throughout the country. The various clans of the Ndebele, more recent immigrants from the south, occupy the area around Bulawayo and Gwanda. Other groups account for 11% of the African populace and include the Tonga near Kariba Lake and the Sotho, Venda and Hlengwe along the southern border.

Caucasians make up less than 1% of the population. Europeans are almost entirely either immigrants from the United Kingdom or South Africa, or their descendants; those from South Africa include a substantial number of South African Dutch (Afrikaner) descent. There are small groups of Portuguese, Italians and other Europeans. Asians and peoples of mixed ancestry make up the remaining 1% (Gall, 2004).

According to the most recent census (ZIMSTAT, 2013), Zimbabwe had a population of 12 973 808, as of 18 August 2012. Of this, 6 234 931 were males and 6 738 877 were females. This means that the overall sex ratio was 93 males for every 100 females. The population constituted 3 076 222 households, with an average of 4.2 persons per household. With an area of 390 757 km^2, Zimbabwe has a low population density of 33 persons per km^2. Figure 1 shows long-term population trends for Zimbabwe from 1960, in the colonial era, to the present. The inter-censal values were obtained using demographic models developed

by the UN Statistics Division, which also predicts a population of 13 771 721 by July 2014. The distribution of the population by province for 2012 indicates that Harare is the most populous province, with 16% of the total population. Manicaland Province comes next with 14%, followed by Midlands (13%), Masvingo (11%), Mashonaland West (11%), Mashonaland Central (9%), Matabeleland North (6%), Bulawayo and Matabeleland South with (5%) each.

In 2011, the Labour Force and Child Labour Survey (LFCLS) showed that the population aged 15 years and above amounted to about 7 000 000. Of this category, just over 87% were economically active (ZIMSTAT, 2013). The survey also showed that, of all economically active persons, 48% were male. There were more males than females in the categories of paid employees and employers, whereas more females than males were self-employed, contributing to a family business or unemployed. However, the bulk of the labour force was self-employed for both males (60.9%) and females (70.1%). The survey also revealed that 11% of the population was unemployed in 2011 (including communal farm workers).

Zimbabwe's public health system lays emphasis on environmental health. The Environmental Impact Assessment Policy adopted in 1994 requires that the impact of any development programme be assessed before it is approved. Zimbabwe has an effective, strong environmental health component, with environmental health workers educating communities on vector control (e.g. mosquitoes) through the use of both chemicals and environmental manipulation. The latter is proving very effective in controlling malaria. Occupational health and safety is enforced in the workplace. In rural areas, programmes have been put in place to improve access to a clean water supply and sanitation. The policy is for each household to have a 'Blair toilet[2]' and for people not to have to walk more than 1 km to the nearest borehole or more than 10 km to the nearest clinic. The implementation of these policies has been delayed, due to the lack of financial resources. By law, waste management is the responsibility of local authorities; the Ministry of Health maintains strict monitoring systems. Food quality in Zimbabwe is monitored through the Food and Food Standards Act[3] and strictly enforced by environmental health workers.

Primary health care is underpinned by a national policy entitled *Planning for Equity in Health* (1984). This policy emphasizes the delivery of primary health care, which includes: education concerning prevailing health problems and methods of preventing and controlling them; promotion of a food supply and proper nutrition; an adequate supply of safe water and basic sanitation; maternal and child health care, including family planning and immunization against major infectious diseases; prevention and control of local endemic diseases; appropriate treatment of common diseases and injuries and provision of essential drugs.

Zimbabwe is one of the countries in Africa most affected by the HIV and AIDS epidemic. HIV prevalence in Zimbabwe was estimated to be 23.7% in 2001, 18.4% in 2005 and 13.1% in 2011. The decline is attributed to the implementation of prevention strategies which stress behaviour change, high condom use and a reduction in the number of sexual partners. High mortality due to the low coverage of antiretroviral therapy has also contributed to the decline, to a lesser extent. Antiretroviral therapy coverage has increased in recent years from 55% (2009) to 79.7 % (2011). An estimated 1 159 097 children and adults were living with HIV and AIDS in 2011 (UNAIDS, 2012).

UNICEF estimates that AIDS has orphaned over one million children in Zimbabwe and that 3.5 million children are living below the poverty line for food. Many more are unable to attend school. In 2005, Zimbabwe launched a *National Action Plan for Orphans and Vulnerable Children*, with support from UNICEF and US$85 million in multi-donor funding. By 2011 when the second phase began, the *National Action Plan* had helped over 500 000 children to access education, health, nutrition and social welfare (Mupfumira, 2011).

2 Designed by the Blair Research Institute; see pages 88 and 131 for details.
3 This act was adopted in 1971 and has been updated several times since, most recently in 2001: www.parlzim.gov.zw/attachments/article/101/Food and Food Standards Act_15_04.pdf

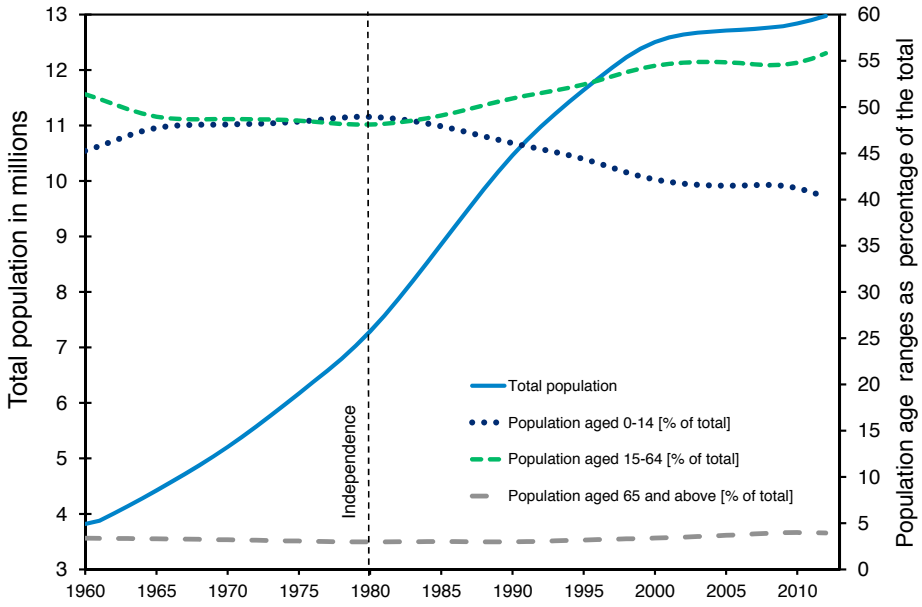


Figure 1: Evolution in the population of Zimbabwe, 1960–2013. Source: UNESCO, based on data provided by UN Statistics Division

Zimbabwe became a signatory to the *Convention on the Rights of the Child* on 8 March 1990 and has since produced a *Children's Action Plan*. Specific programmes to protect children's health and welfare include Child Supplementary Feeding, for children under the age of five, and Promotion of Breast Feeding. To date, 39 baby-friendly hospitals have been established which promote the exclusive use of breast milk. Growth monitoring programmes have been introduced at every clinic and in every community, the only limitation being the availability of scales.

HUMAN DEVELOPMENT IN ZIMBABWE

The concept of human development focuses on the end result rather than the means of achieving development. This holistic approach puts people at the centre of the development process. Since 1989, the United Nations Development Programme (UNDP) has been measuring the Human Development Index (HDI). The latter measures the average achievements of a country for three basic dimensions of human development: a long and healthy life, access to knowledge and a decent standard of living. Data availability determines the HDI country coverage. The three dimensions are normalized with the corresponding lowest and highest values obtained from a sample of 187 countries then combined into a single index. Each country will have a HDI value situated between 0 and 1. The global rank of countries is obtained by representing each individual HDI value in descending order.

Countries are classified as being of very high, high, medium or low development, according to their ranking. Africa's breakthrough came in 2013 when the Seychelles achieved very high human development with a rank of 46th place, ahead of wealthier states in Europe and the Middle East. Algeria, Libya, Mauritius and Tunisia were attributed high human development, while ten other African countries reached medium human development. The remaining 37 African countries fall in the low human development category, South Sudan being precluded from the study (UNDP, 2013).

Zimbabwe's HDI value for 2012 is 0.397, placing it in the low human development category with a ranking of 172nd out of 187 countries and territories. Between 1980 and 2012, Zimbabwe's HDI value increased by 8% from 0.367 to 0.397, an average annual increase of about 0.2%. Zimbabwe's HDI is below the average of 0.466 for countries in the low human development category and below the average of 0.475 for countries in sub-Saharan Africa. From Sub-Saharan Africa, countries which are close to Zimbabwe in 2012 HDI rank and population size are Lesotho and Kenya, which have HDIs ranked 158 and 145 respectively. Figure 2 shows the long-term evolution in the HDI of Zimbabwe, following the latest measurement methodology (UNDP, 2013).

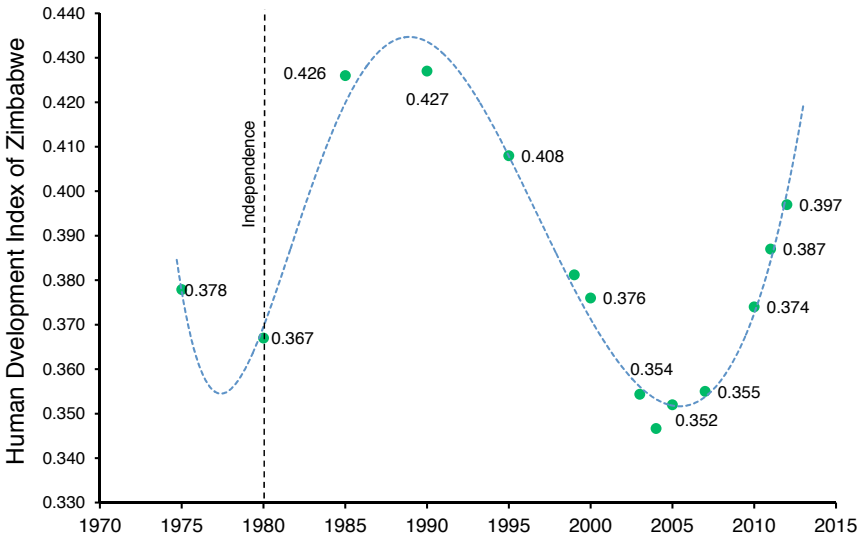


Figure 2: Evolution in Zimbabwe's Human Development Index, 1970–2012. Source: UNESCO estimation, adjusted according to the latest HDI methodological approach and data provided by UNDP (2013)

By decoupling the HDI in their three main components, it is possible to explain the erratic behaviour shown in Figure 2. For example, one of the components, life expectancy at birth, continuously rose in value between 1960 and 1986 when it peaked at 63.4 years for women and 59.4 years for men. By 2003, this indicator had plummeted to 42.4 years for women and 43.4 years for men. Life expectancy is now rising again (see Figure 3). GDP per capita (in constant US$2012) rose steadily from 1960 to 1974. Following independence in 1980, it oscillated around US$700–800 until 1998 when GDP per capita slumped to less than US$400 in a decade. Since then, the value has slowly begun to recover (see Figure 4). When it comes to education, the trend is more linear: between 1980 and 2012, mean years of schooling increased by 4.0 years and expected years of schooling increased by 3.6 years.

Recent *Human Development Reports* have launched an Inequality Adjusted Human Development Index (IHDI) and Gender Inequality Index (GII) alongside the HDI. The GII reflects gender-based disadvantages in reproductive health, empowerment and the labour market. Countries with better gender equality tend to have low maternal mortality, low adolescent fertility and a high proportion of males and females with at least secondary education. With a GII of 0.544, Zimbabwe falls in the lower gender inequality group in Africa. The HDI for Africa as a whole drops to 0.284 when gender inequality is taken into account, a loss of 28.5%. High inequality is undermining the positive impact of Africa's economic growth. Gender inequality on the continent is linked to the persistence of discriminatory laws, norms and practices which restrict the access of women and girls to opportunities, resources and power (see Box 1 and Table 1).

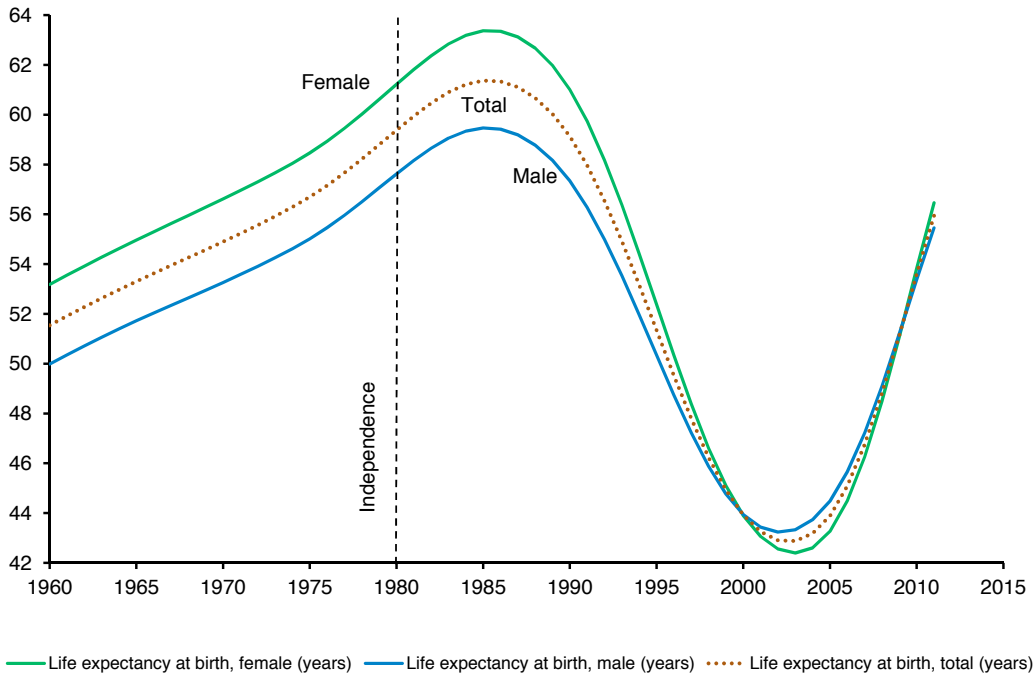


Figure 3: Evolution in life expectancy at birth in Zimbabwe, 1960–2012. Source: UNESCO, based on raw data provided by UN Statistics Division

BOX 1 – ZIMBABWE'S NATIONAL GENDER POLICY (2013–2017)

The quest for gender equity has evolved from the stage of advocacy, negotiation and consensus-building, as well as awareness-raising on the importance of gender equity to the point where gender considerations are an obligation in development programming and implementation. The government's second National Gender Policy (2013–2017) replaces the first National Gender Policy crafted in 2004.

The first policy framework provided a gender perspective for the principle of 'growth with equity' that had been adopted by Zimbabwe to address gender and race inequities. The first policy was responsible for some notable achievements. Primary among these was the increase in awareness of gender equality and equity as an imperative for social justice and sound economics. This has seen earnest initiatives for gender mainstreaming across all sectors.

The constitution adopted in 2013 makes explicit provisions for gender equality, making it necessary to update the gender policy. Other priorities are also emerging through the Protocol on Gender and Development adopted in 2008 by the Southern African Development Community (SADC), as well as through national initiatives addressing Climate Change, Zimbabwe's Land Reform, the Economic Recovery Programme and the Indigenisation and Empowerment framework, among others. All these spell out new commitments necessitating an alignment of the mission promoting gender equality and equity with this complex new landscape. The main characteristics of the second National Gender Policy are the following:

Vision: a gender-just society, in which men and women enjoy equity, contribute to the country's development, and benefit from this development, as equal partners.

Goal: to eradicate gender discrimination and inequalities from all spheres of life and development.

Policy Objectives: to reach this goal, the following objectives have been formulated around the eight priority areas:

1 Gender, Constitutional and Legal Rights: to ensure that the constitutional and legislative provisions on gender justice are implemented and that gender equality targets set in national and international and regional protocols to which Zimbabwe is a Party are achieved.
2 Gender and Economic Empowerment: to promote equality and equity in access to economic opportunities for men and women, as well as in access to the benefits of the country's economic development.
3 Gender, Politics and Decision Making: to create a supportive environment for gender parity in politics and decision-making positions.
4 Gender and Health: to promote gender sensitivity in health service delivery.
5 Gender, Education and Training: to promote (i) equal access to education for boys and girls and their retention at all levels of education; and (ii) access to training opportunities for men and women, to make possible their equal participation in the workplace, marketplace and in governance structures.
6 Gender-based Violence: to reduce all forms of gender-based violence in Zimbabwe.
7 Gender, Environment and Climate Change: to increase the gender responsiveness of strategies related to environmental and natural resources management, as well as of climate change adaptation and mitigation initiatives.
8 Gender, Media and ICTs: to promote equal access to, control and ownership of, media and ICTs by men and women to enhance development across all sectors.

Principles Guiding the Policy: The policy is underpinned by the following set of principles which guide its implementation:

- Gender Justice in all sectors of development: gender justice forms the critical ingredient of this policy. Gender justice takes a rights-based approach, whereby, as elaborated in the Constitution, both men and women shall enjoy equal rights defined in the bill of rights. Noting further that, in pursuit of addressing disparity through advancing one sex, the processes should not ultimately marginalize or prejudice the other or result in reverse discrimination.
- *Affirmative Action*: notwithstanding the principle of gender justice, this policy acknowledges the legitimacy of measures (legislative or other) designed to counter previous unfair discrimination. As such, affirmative action shall be pursued to speed up progress in redressing gender inequality, particularly where targets have to be met within set timeframes.
- *Integration of Gender Perspectives in all Aspects of Development*: all multi-sectoral actors (state and non-state) shall take appropriate action to address gender inequalities in areas within their mandate, in line with this policy. This entails, among other things, the development of sector-specific gender policies aligned with the National Gender Policy, integrating the gender perspective in planning, policy-making, programme design, monitoring and evaluation, in addition to pursuing collaborative partnerships, whenever necessary. Enhancing the capacity of development personnel to address gender systematically in their work becomes a central tenet of this principle.
- *Broad-based Engagement and Inclusivity*: this principle calls for the appreciation of all forms of social, economic and political difference (age, religion, disability, cultural, educational, language, economic, geographical, etc). It seeks to engage stakeholders across all sectors and to be of benefit to men, women, boys and girls from all levels and of all backgrounds and to allow special consideration for certain marginalized groups, whenever necessary.
- *Peace and Harmony at Family and Community Levels*: this principle is a fundamental ingredient, if this policy is to have a positive outcome. Peace and harmony at family level contribute to fair appropriation, ownership and control of productive assets among men, women, boys and girls at both family and community levels. It also contributes to meaningful participation in decision-making and development.

National Gender Policy and the need for new research tools

The policy calls for public and private research institutions, as well as ZIMSTAT, to:

(a) develop standardized research methods and tools for collecting gender-disaggregated data and gender equality reporting, monitoring and evaluation;

(b) develop research programmes and mobilize resources for conducting research, in order to ensure the successful implementation of the National Gender Policy;

(c) contribute to evidence-based gender legislation, policy reviews and programmes.

Source: Republic of Zimbabwe (2013c) *National Gender Policy (2013–2017),* Ministry of Women's Affairs, Gender and Community Development: Harare.

Table 1: Quality of life in Zimbabwe

Indicator	Value (2012)
Human Development Index (HDI)	
HDI [value]	0.397
HDI [world ranking out of 187 countries]	172
Health	
Public expenditure on health [% of GDP]	n/a
Under-five mortality [per 1 000 live births]	89.8
Life expectancy at birth [years]	52.7
Education*	
Public expenditure on education [% of GDP 2010]	2.5
Primary school teachers trained to teach [%]	n/a
Primary school dropout rates [% of primary school cohort]	n/a
Expected years of schooling [of children] [years]	10.1
Adult literacy rate, both sexes [% aged 15 and above]	84.5
Mean years of schooling [of adults] [years]	7.2
Combined gross enrolment in education [both sexes]	n/a
Inequality	
Loss due to inequality in life expectancy [%]	24.3
Gender	
Population with at least secondary education [ratio of females to males]	n/a
Adolescent fertility rate [births per 1000 women aged 15–19]	62.7
Labour force participation rate [ratio of females to males]	0.9
Gender Inequality Index, value	0.544
Women in Parliament [ratio of females to males]	0.218
Maternal mortality rate [deaths of women per 100 000 live births]	960
Sustainability	
Carbon dioxide emissions per capita [tonnes]	n/a
Change in forest area, 1990/2010 [%]	n/a
Demography	
Population, total both sexes** [thousands]	13 061.2
Population, urban [% of population]	39.1
Population, female** [thousands]	6 606.6
Population, male** [thousands]	6 454.6
Income	
GDP per capita [2012 US$PPP]	484

*The UNESCO Institute for Statistics provides the education data for UNDP's *Human Development Reports*
** The population figure given here differs slightly from the findings of the 2012 ZIMSTAT survey, see pages 4–5

Source: UNDP (2013) *Human Development Report*

THE RUGGED LANDSCAPE OF THE ZIMBABWEAN ECONOMY

The rugged landscape of the Zimbabwean economy is rooted in the interaction between historical factors and the discriminatory policies of colonial administrations which skewed economic fundamentals. Following colonial occupation, productive land and mineral resources were compulsorily acquired as the African population was crowded into the infertile, low-rainfall, marginal Tribal Trust lands (UNDP, 2000).

Today, land, industrial and other productive assets continue to be unequally distributed among the population, with the majority of the rural population living in impoverished, marginally productive areas with low rainfall. The uneven – regional and sectoral – distribution of national income has contributed to a lopsided economy which caters largely to the needs of the urban formal economy.

Yet, independence in 1980 gave Zimbabwe an opportunity to redress the unjust economic governance of the past. The economy experienced a major boom in the first two years of independence, largely due to access to international assistance and lending, favourable terms for trade, good weather conditions for agriculture and increased aggregate demand stemming from a rise in wages and agricultural income. This post-independence boom resulted in a surge in capacity utilization by industry, from 75% at independence to 95% in 1981 (Green and Kadhani, 1986). For details of capacity utilization in Zimbabwe, see page 30.

The new government sought to enlist the participation and active support of its citizens in the development process (Republic of Zimbabwe, 1981). It espoused the importance of 'popular democratic participation in the ownership and management of national resources.' The new government added to the utilities and agricultural marketing agencies it had inherited from the previous regime by buying out more private companies. The government also extended existing protectionist policies and introduced a minimum wage. Between 1970 and 1990, government spending on education and health care nearly tripled. Although this had positive socio-economic repercussions, central government expenditure also tripled over this period, with its share of GDP rising from 32.5% to 44.6% between 1979 and 1989 (Davies and Rattsø , 1999; Brett, 2005).

GDP per capita actually remained fairly stable between 1980 and 1998, fluctuating between US$700 and US$800. Figure 4 compares the trend in Zimbabwe between 1960 and 2013 with that for the whole of sub-Saharan Africa. It shows that the gap in GDP per capita between Zimbabwe and sub-Saharan Africa as a whole shrank from US$360 in 1979 to just US$60 twenty years later, in constant 2012 US$. In 1998, however, Zimbabwe began experiencing escalating economic challenges which affected almost all sectors of the economy and took on crisis proportions in 2007 and 2008. In July 2008, official inflation peaked at 231 000 000% and, by January 2009, capacity utilization in industry had fallen below 10%.

Between 1998 and 2008, total GDP is estimated to have contracted by a cumulative 50.3% and GDP per capita had plunged to less than US$400. The gap in GDP per capita between Zimbabwe and sub-Saharan Africa as a whole widened from US$60 in 1998 to a record high of US$691 in 2008 – a gap 192% wider than prior to independence in 1979. The country also faced sanctions from some Western countries and the cessation of funding from the Bretton Woods Institutions[4].

By 2008, 90% of the adult population was unemployed and 80% of Zimbabweans were living in poverty. Infrastructure had deteriorated, the economy had become more informal and there were severe food and foreign currency shortages. The significant gains achieved after independence in 1980 in terms of reducing poverty and inequality and improving the general economy had largely been reversed (see Figures 2, 3, 4, 5 and 8).

4 In 2002, the International Monetary Fund (IMF) adopted a declaration of non-cooperation with Zimbabwe and suspended its technical assistance to the country, due to the non-payment of arrears.

BOX 2 – FURTHER ANCHORING INDIGENOUS KNOWLEDGE SYSTEMS IN ZIMBABWE'S RESEARCH AND INNOVATION POLICIES

Shortly after its founding in 2004, the Zimbabwe Academy of Sciences (Chetsanga et al., 2009) recognized the need for a national policy acknowledging officially the role of traditional medicine in healthcare delivery. More Zimbabweans consult traditional healers in their communities than Western-type medical centres. It is known that many of these traditional treatments provide effective healing.

The academy considered it a priority for the country to set up research centres to study the chemical composition and effectiveness of traditional medicines. Such studies should make it possible to validate the curative properties of some of the medicines used by traditional healers and, consequently, design appropriate prescription dosages. For the Zimbabwe Academy of Sciences, this approach should include provision for awarding intellectual property rights to the healers who submit samples of the chemically analysed traditional medicines.

International recognition of the importance of indigenous and local knowledge was triggered by the 1992 Convention on Biological Diversity and its well-known article 8(j):

> *'respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge innovations and practices.'*

Over the past few decades, governments have addressed the issues of knowledge access and benefit-sharing, including through the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization (2010). Negotiations relating specifically to intellectual property continue through WIPO's Intergovernmental Committee on Intellectual Property and Genetic Resources, Traditional Knowledge and Folklore.

Growing attention is also being paid to the wider application of indigenous knowledge systems, as well as to its multiple dimensions. Beyond its contribution to identifying valuable genetic resources with applications in health, agriculture or industry, indigenous knowledge has gained growing recognition in such diverse fields as renewable resources, wildlife or fisheries management, natural disaster preparedness and response, environmental impact assessment and climate change assessment and adaptation. Recently, for example, the Intergovernmental Panel of Experts on Climate Change (IPCC) has encouraged authors of the Fifth Assessment Report, published in three volumes in 2013 and 2014, to consider indigenous knowledge alongside scientific knowledge when assessing the impact of climate change and opportunities for adaptation. Similarly, the newly established Intergovernmental Platform on Biodiversity and Ecosystems Services (IPBES)[5], which counts Zimbabwe among its current 118 members, has adopted as one of its founding principles, to 'recognize and respect the contribution of indigenous and local knowledge to the conservation and sustainable use of biodiversity and ecosystems'. These emerging fields of relevance to indigenous knowledge might also be considered through the development of an indigenous knowledge systems policy for Zimbabwe's sustainable development.

Such a policy might also provide Zimbabwe with the opportunity to consider the multiple dimensions of indigenous knowledge systems. Indigenous knowledge, for example, has gained specific recognition for its heritage values through UNESCO's 2003 Convention for the Safeguarding of the Intangible Cultural Heritage. Recognition of the value of indigenous knowledge systems should be accompanied by a long-term vision not only of what these can

5 Based in Bonn, Germany, IPBES was formally established in 2012 and is co-sponsored by UNEP, UNDP, UNESCO and FAO. See http://ipbes.net

contribute to Zimbabwe's sustainable development but also a reflection on what measures may be required to ensure the long-term vitality of indigenous knowledge systems themselves. This also brings forward the issue of the continuing transmission of such knowledge and its relationship to education systems, non-formal and formal. The UN Convention on the Rights of the Child underlines the importance of education that respects the language and culture of indigenous children. Ensuring the longevity and dynamism of indigenous knowledge systems, including through intercultural and mother tongue education, is also an investment in the long-term opportunities that these systems can bring Zimbabwean society.

Zimbabwe is one of the nine signatories of the Swakopmund Protocol on the Protection of Traditional Knowledge and Expressions of Folklore. The protocol was adopted in Namibia in 2010 by member states of the African Regional Intellectual Property Organization (see pages 77 and 169, for details).

The importance of traditional knowledge is recognized in the United Nations Declaration on the Rights of Indigenous Peoples (2007), adapted to the African context through the deliberations of the African Court of Human Rights, which provides a holistic framework for an enlarged and multidimensional vision of indigenous knowledge systems that can bring long-term benefits to Zimbabwe.

Source: UNESCO's Local and Indigenous Knowledge Systems (LINKS) programme

The Fast-track Land Reform Programme implemented from 2000 onwards contributed to the decline in agricultural production by reducing the cropping area of traditionally large commercial crops, such as maize and wheat (see Box 3). However, other factors entered into play. Notably, the Fast-track Land Reform Programme coincided with Zimbabwe's economic crisis. Farmers were confronted with hyperinflation, high interest rates, market failures and shortages of major productive inputs (seeds, fuel, fertilizer, etc), as well as foreign currency (Mujeyi, 2010).

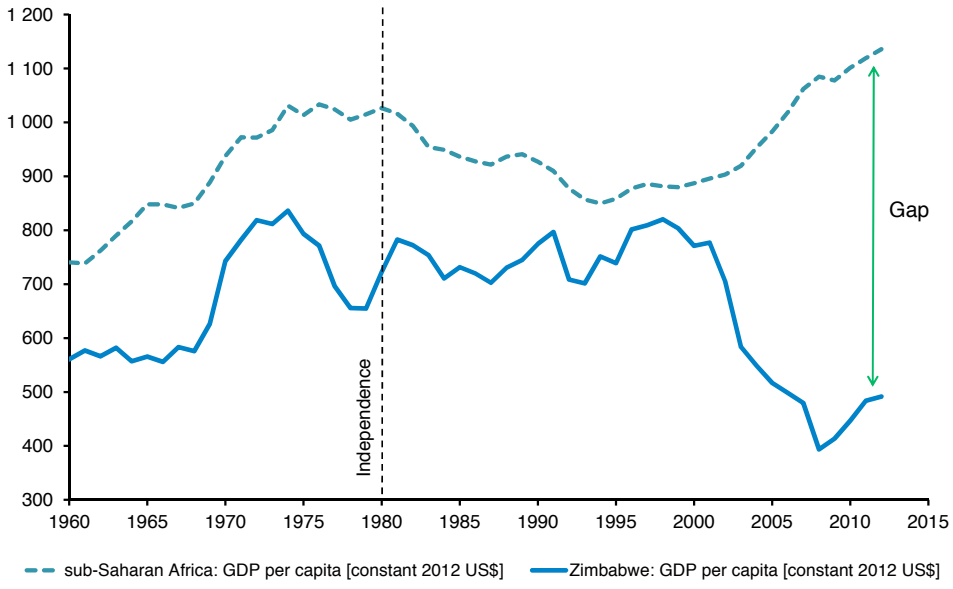


Figure 4: Evolution of GDP per capita, expressed in constant 2012 US$, in Zimbabwe and sub-Saharan Africa, 1960–2013. Source: UNESCO, based on data provided by UN Statistics Division (Population), World Bank (GDP in US$) and US Census Office (GDP deflactor).

BOX 3 – COMPENSATION AND NATIONALIZATION POLICIES

Nationalization is the process by which a national government or state takes a private industry or private assets into public ownership. Land reform in Zimbabwe officially began in 1979 with the signing of the Lancaster House Agreement, in an effort to distribute land more equitably between the historically disenfranchised blacks and the minority whites who had ruled Zimbabwe during the colonial era.

The government's land redistribution programme is perhaps Zimbabwe's most crucial and most bitterly contested political issue. It can be divided into two periods: from 1979 to 2000, the principle of 'willing buyer, willing seller' was applied, with economic support from Great Britain; from 2000 onwards, this scheme was replaced by the Fast-track Land Reform Programme.

The 1985 Land Acquisition Act respected the 'willing seller, willing buyer' clause, in keeping with the terms of the Lancaster House Agreement which stated that the clause could not be changed for ten years. The Act had a limited effect, however, as the government lacked the means to compensate landowners and many white farmers did not wish to sell. Between 1980 and 1990, the government acquired just 40% of the targeted 8 million hectares of land.

The 1992 Land Acquisition Act was enacted to speed up the land reform process by removing the 'willing seller, willing buyer' clause. The Act limited the size of farms and introduced a land tax, although the latter was never implemented. The Act empowered the government to buy land compulsorily for redistribution in return for fair compensation.

In February 2000, the referendum on the new constitution was rejected. The text had contained a clause authorizing the government to seize private land without compensation. The subsequent Fast-track Land Reform Programme, which resorted to evictions, redistributed much of the commercial farmland to families, 140,000 of which were 'non-elites', according to Moyo (2009). The land redistribution exercise is now complete. According to Mujeyi (2010), over 7 million hectares of land has been transferred to both small-scale farm units and larger scale farms.

The Indigenisation and Economic Empowerment Act 14 was passed by Parliament towards the end of 2007 and signed into law on 17 April 2008. This provided for all companies operating in Zimbabwe to arrange for 51% of their shares, or company interests, to be owned by indigenous Zimbabweans.

On 29 January 2010, the Zimbabwean government published regulations with respect to the act that include the requirement for companies operating in Zimbabwe to provide the Minister of Youth Development, Indigenisation and Empowerment with specified information. The main provisions of the Indigenisation and Economic Empowerment Regulations are that every existing business with an asset value of US$500 000 or more, whether foreign or domestic, has to submit completed official forms describing the business and showing how it plans to ensure that indigenous Zimbabweans will own at least 51% of the company shares. Plans to restructure or unbundle businesses or to merge or demerge businesses, as well as investment proposals that require an investment license, must be submitted for approval before they can be carried out.

Sectors reserved for indigenous Zimbabwean investors include the growing of food and cash crops, the provision of buses, taxies and car-hire services, retail and wholesale trade, barber shops, hairdressing and beauty salons, employment agencies, estate agencies, valet services, grain milling, bakeries, tobacco grading, processing and packing, advertising agencies, milk processing and the provision of local arts and crafts, as well as the marketing and distribution of these items. Business owners wishing to identify suitable indigenous partners will be invited to register their names in a database to be established by the ministry. Likewise, the names of indigenous Zimbabweans wishing to become business partners will be recorded in a special database.

The government's interventionist macro-economic policies impinged on production systems and the functioning of formal markets. In July 2001, the government made maize and wheat controlled products under Statutory Instrument 235A, which criminalized the sale of these crops by farmers to any market player other than the Grain Marketing Board. This led to the proliferation of parallel markets. The government 'introduced product price controls, fixed the exchange rate at highly overvalued levels, rationed its allocation and imposed export restrictions,' implicitly taxing food production. It then attempted to compensate for the distortions by controlling the price of seeds, fertilizer, fuel and other inputs. Production of inputs dropped, pushing up prices on parallel markets until these inputs became unaffordable for farmers. In a nutshell, the government's macro-economic policies 'discouraged production and promoted speculative tendencies'(Mujeyi, 2010). Mujeyi (2010) observes that, for the most part, farmers survived the economic crisis. The failure of formal markets, combined with growing local demand for agricultural produce, resulted in 'new circuits of economic interaction that are not mediated through the state or parastatal authorities.'

The adoption of a multi-currency payment system in February 2009 marked a significant shift in economic policy. This was reinforced by the crafting and implementation of the Short Term Economic Recovery Programme (STERP I and II), its implementation instrument, the *One Hundred Day Plan* and a revized 2009 national budget denominated in US dollars. These policy measures provided an antidote to the scourge of hyperinflation and a holistic macroeconomic framework for economic recovery. The economy responded positively to these initiatives, with GDP growing by 5.7% in 2009. Industrial capacity utilization improved from about 10% at the beginning of 2009 to between 35% and 60% by the end of that year.

Other significant macro-economic changes included price liberalization, removal of surrender requirements on export earnings, removal of exchange restrictions, the end of the monopoly of the Grain Marketing Board, the imposition of budgetary cuts on parastatals and the reform of monetary and fiscal policy frameworks and institutions like the Reserve Bank of Zimbabwe.

Today, the Zimbabwean macro-economic framework for 2014–2015 is built on an active policy scenario, which projects real GDP growth of about 6.1% in 2014 and 6.4% in 2015 (see Table 2). This translates into

Table 2: Macro-economic and budgetary projections, 2014–2015

	2009	2010	2011	2012	2013 Est.	2014 Prj	2015 Prj.
National Accounts (Real Sector)							
Real GDP at market prices (million US$)	8 157	9 085	10 167	11 241	11 626	12 337	13 123
Nominal GDP at market prices (million US$)	8 157	9 457	10 956	12 472	13 099	14 065	15 228
Real GDP Growth (%)	5.4	11.4	11.9	10.6	3.4	6.1	6.4
Inflation [annual average] (%)	-7.9	3.0	3.5	3.8	1.7	1.5	2.0
Government Accounts							
Revenues & Grants (Millions US$)	934	2 198	2 770	3 452	3 722	4 120	4 340
As % of GDP	11.4	23.2	25.3	27.7	28.4	29.3	28.5
Expenditures & Net Lending (million US$)	966	2 228	3 102	3 746	4 057	4 120	4 340
As % of GDP	11.8	23.6	28.3	30.0	31.0	29.3	28.5
Balance of Payments Accounts							
Exports (million US$)	1 796	3 541	4 771	4 355	4 430	5 024	5 524
Imports (million US$)	3 662	5 834	8 491	7 456	7 682	8 321	8 690
Current Account Balance (million US$)	-1 140	-1 918	-3 127	-2 380	-2 550	-2 471	-2 299

Source: Republic of Zimbabwe (2013b), p. 94

nominal GDP of about US$14,065 million (current dollars), up by almost 7% from nominal GDP of about US$13,099 million in 2013. This is consistent with the single-digit average annual inflation of about 1.5% estimated by the authorities (Republic of Zimbabwe, 2013b).

The year 2013 was marked by a series of socio-political events which required huge funding against limited budgetary resources. These included the conduct of the constitutional referendum in March 2013, leading to the harmonized elections on 31 July 2013 (Republic of Zimbabwe, 2013b). As a result, the real economy grew modestly by an estimated 3.4% in 2013. The main drivers were mining, construction and tourism (see Table 3). Based on a policy scenario anchored in the strong recovery of agriculture and improved performance of the mining and construction sectors, the economy is projected to grow by 6.1% in 2014.

The country's economic decline between 1998 and 2008 severely constrained research and innovation in Zimbabwe. The country essentially relied on donors for research funding in the 1990s but, by 2003, most donors had suspended their operations in Zimbabwe. Repeated currency devaluations and hyperinflation exacerbated matters during 2002–2008, further eroding funding levels at R&D agencies and hence their ability to conduct viable research. The persistently low level of R&D funding has deprived SETI of its desired role a driver of socio-economic development in Zimbabwe.

Table 3: Real sector growth projections for 2013–2015 (%)

Items	2009 Actual	2010 Actual	2011 Actual	2012 Est.	2013 Proj.	2014 Proj.	2015 Proj.
Agriculture, hunting and fishing	37.6	7.2	1.4	7.8	-1.3	9.0	5.1
Mining and quarrying	18.9	37.4	24.4	8.0	6.5	11.4	9.2
Manufacturing	17.0	2.0	13.8	5.3	1.5	3.2	6.5
Electricity and water	1.9	19.5	6.4	0.3	4.2	4.5	7.0
Construction	2.1	14.1	65.1	23.5	10.0	11.0	13.5
Finance and insurance	4.5	8.3	8.3	28.0	2.6	6.3	6.2
Real estate	2.0	4.9	48.9	59.0	10.0	11.0	13.5
Distribution, hotels and restaurants	6.5	8.8	4.3	4.3	3.4	5.1	5.0
Transport and communication	2.2	4.7	0.0	6.7	3.4	4.0	5.5
GDP at market prices	5.4	11.4	11.9	10.6	3.4	6.1	6.4

Source: Reserve Bank of Zimbabwe, Zimbabwe National Statistics Agency and Ministry of Finance and Economic Development (2013)

ZIMBABWE AGENDA FOR SUSTAINABLE SOCIO-ECONOMIC TRANSFORMATION, 2013-2018 (ZIMASSET)

In pursuit of a new trajectory for accelerated economic growth and wealth creation, the Zimbabwean government has formulated a new plan known as the *Zimbabwe Agenda for Sustainable Socio-Economic Transformation* (ZimASSET), 2013–2018.

ZimASSET has been crafted to foster sustainable development and social equity anchored in indigenization, empowerment and employment creation. Its mission is described as being 'To provide an enabling environment for sustainable economic empowerment and social transformation to the people of Zimbabwe.'

The plan will largely be propelled by the judicious exploitation of the country's abundant human and natural resources. It is built around four strategic clusters designed to foster economic growth and reposition the country as one of the strongest economies in the SADC region and in Africa as a whole.

The four strategic clusters are: (a) food security and nutrition; (b) social services and poverty eradication; (c) infrastructure and utilities; and (d) value addition and beneficiation.

To buttress the aforementioned clusters, two sub-clusters have also been developed, namely: (i) fiscal reform measures and public administration and (ii) governance and performance management.

For easy conceptualization, comprehension and appreciation of the key outcomes and outputs, ZimASSET is set out in matrix form. This should ensure the institutionalization and mainstreaming of a results-based culture in the public sector, in conformity with the Results-based Management System. Under this arrangement, initiatives identified under each cluster will be implemented immediately to yield rapid results (Quick Wins) in the shortest possible time frame (October 2013 – December 2015). In the process, the government is planning to undertake blitz interventions in the delivery of services.

The plan will use the macroeconomic budgetary framework devised by the Treasury as the basis for implementation, commencing with the 2014 fiscal year. In order to ensure that the plan is fully funded, the following, *inter alia*, have been identified as financing mechanisms: tax and non-tax revenue, leveraging of resources, sovereign wealth fund, issuance of bonds, accelerated implementation of public–private partnerships, securitization of remittances, re-engagement with the international and multilateral financial institutions and other financing options and a focus on Brazil, Russia, India, China and South Africa (BRICS).

The Office of the President and Cabinet will monitor and evaluate the implementation, monitoring and evaluation of the plan. With this implementation plan, the economy is projected to grow by an average of 7.3%. It is expected to grow by 6.2% in 2014 and continue on an upward growth trajectory to 9.9% by 2018.

ZimAsset replaces the *Medium Term Plan 2011–2015* elaborated by the previous government.

BOX 4 – INVESTMENT OPPORTUNITIES AND INCENTIVES IN ZIMBABWE

The Zimbabwe Investment Authority stresses that Zimbabwe, as an agro-based economy, provides opportunities in meat processing, fish processing, food processing, fruit juice manufacturing, horticulture and floriculture, processing of cotton lint, cigarette manufacturing, timber processing, etc. Investors can also commit resources to primary production of food and cash crops, primary horticulture, game, wildlife ranching, livestock, poultry farming, fishing and fish farming. Investments in the agricultural sector can take many forms, depending on the investment area and type of investor. Examples are: public–private partnerships; equity and non-equity partnerships; build, own, operate and transfer; build, operate and transfer; joint ventures; contract farming and; green businesses.

The Zimbabwe Revenue Authority administers various tax incentives aimed at promoting investment, whereas the Ministry of Industry and Commerce, the Industrial Development Corporation and the Zimbabwe Investment Authority are the main administrators of non-tax incentives.

Revenue incentives in Zimbabwe apply equally to both domestic and foreign investors, with the main goal of incentives being: (a) income generation; (b) export processing; (c) employment creation and skills transfer; (d) small business development; (e) industrial development and; (f) revenue inflows.

Like many other countries, Zimbabwe offers a number of tax and customs incentives in the form of tax holidays, reduced tax rates and accelerated depreciation. These incentives are given by sector, type of activity, form of organization and geographical location of the investment. Tax incentives relevant to the agricultural, industrial and manufacturing sectors include:

Income taxes

Build, own, operate and transfer (BOOT) and build, operate and transfer (BOT) arrangements: contractors may enter into contracts with the state or a statutory corporation which undertakes to construct infrastructure for them. This confers the right to operate or control the infrastructure for a specified period, after which the contractor will transfer ownership or control of the item to the state or statutory corporation. The investor enjoys a tax holiday for the first five years and is taxed at 15% for the following five years.

Manufacturing companies reduced tax rate: taxable income from a manufacturing or processing company which exports 50% or more of its output is taxed at a special rate of 20%.

Special initial allowance (SIA): this is a capital allowance which ranks as a deduction on expenditure incurred in the construction of new industrial buildings, farm improvements, railway lines, staff housing and tobacco barns. SIA is also allowed for additions or alterations to existing items and for articles, implements, machinery and utensils purchased for the purposes of trade. The allowance is optional and, once claimed, replaces wear and tear. It is allowed at the rate of 25% of the cost from year one.

Farmers' special deductions: farmers are allowed special deductions over and above the normal deductions, for instance, for expenditure on fencing, clearing and stamping land, sinking boreholes, wells and aerial and geophysical surveys.

Double Taxation Agreements (DTA): Zimbabwe has signed several DTA to avoid or mitigate double taxation of the same income in two countries which are signatories to the agreement, in other words, where a business entity operates on both territories. The agreements restrict some withholding taxes to the amounts specified for fees. As an example, almost all the DTAs signed limit the tax rate on *technical fees to 10%* or less.

Value-added Tax

Farming inputs and equipment are subject to VAT at 0%: most farm inputs are exempted from VAT, such as animal feed, animal remedies, fertilizer, plants, seeds, pesticides and equipment, or machinery used for agricultural purposes.

Deferment of collection of VAT on the importation of capital goods: Value-added tax can be deferred on some capital equipment for the exclusive use of mining, manufacturing, agriculture and the energy and aviation industries, investment in which generally relies on imported capital. The full amount becomes due within 90 days of the date of deferment.

ATTRACTING FOREIGN DIRECT INVESTMENT

Foreign direct investment[6] (FDI) is also usually considered a major source of growth. FDI is an important source of finance for transition economies, as it helps to cover the current account deficit, fiscal deficit (in case of privatization-related FDI) and supplements inadequate domestic resources to finance both ownership change and capital formation.

Secondly, compared with other financing options, FDI facilitates transfer of technology, know-how and skills and helps local enterprises expand into foreign markets. It not only increases the activity of FDI-beneficiary firms but can also have a knock-on effect on other firms and sectors through technological spillover and increased competition, thus raising productivity for the whole economy.

Countries can increase the inflow of FDI by creating a business climate that makes foreign investors feel that their capital is safe. Among the incentives that countries can offer, one could cite low tax rates or other tax incentives, protection of private property rights, access to loans and funding, and infrastructure that allows the fruits of capital investment to reach the market.

According to the latest *World Investment Report* (UNCTAD, 2013), developing countries accounted for a record 52% of global FDI inflows in 2012, exceeding flows to developed economies for the first time ever, by US$142 billion. On the other hand, FDI flows to, and from, developed economies declined by 32% to US$561 billion, a level that was last seen a decade ago.

Technological innovation can be transferred to foreign economies through various channels, such as FDI, international trade and the international diffusion of knowledge and innovation. Technology transfer may be a major reason for the growth in *total factor productivity* (TFP) in many economies. Wang and Wong (2012) demonstrated that, over the period 1986–2007, foreign R&D, transferred through inward FDI and imports, improved the technical efficiency of countries by an estimated 9.97% on average. This indicates that, for a country with an average level of technical efficiency of 0.85, its efficiency score would have dropped to about 0.72 had it not received any international R&D through FDI and imports.

For this reason, FDI is an effective conduit for technology transfer through technology spillovers to domestically owned firms in the host country. Managia and Bwalya (2010) analysed the significance of productivity externalities of FDI to local firms, in terms of both intra-industry and inter-industry spillovers, using firm-level data from Kenya, Tanzania and Zimbabwe. The results show evidences in support of intra- and inter-industry productivity spillovers from FDI for Kenya and Zimbabwe. These indicate that significant knowledge spillovers occur through backward linkages from foreign firms in upstream sectors to local firms

6 The International Monetary Fund defines (foreign) direct investment in its *Balance of Payments Manual* as the category of international investment that reflects the objective of obtaining a lasting interest by a resident entity in one economy (direct investor) in an enterprise resident in another economy (direct investment enterprise). Direct investor is defined by its ownership of 10% or more of the ordinary shares or voting power in a direct investment enterprise.

in downstream sectors. This is consistent with the vertical technology spillover hypothesis. Foreign firms have an incentive to facilitate knowledge transfer to local firms to enable them produce intermediate inputs more efficiently, thereby making them available to foreign firms upstream at a lower cost.

Many African governments have implemented investment-friendly frameworks to attract more foreign investment. Nonetheless, most foreign investment in Africa goes to extractive industries in a relatively limited group of countries. Thus, the broader development impact of FDI-backed projects is often limited. Attracting investment into diversified and higher value-added sectors remains a challenge for Africa. However, constraints on investment such as weak infrastructure and fragmented markets also adversely affect FDI flows to Africa. FDI levels still vary widely by region, sector and country.

At the time of independence in 1980, the new Zimbabwean government adopted a highly controlled and inward looking economy. Foreign capital constituted about 70% of the total capital stock and FDI dominated foreign capital inflows (Clarke, 1980). Owing to the policy environment, which was unfavourable to foreign investors, FDI inflows were very low during the first decade of independence (Gwenhamo, 2011).

FDI trends in Zimbabwe since 1990

Table 4 shows the long-term evolution of FDI inflow, outflow and FDI inflow/gross fixed capital formation[7] (GFCF) for Zimbabwe between 1990 and 2012. The sharp surge in FDI inflow in 1998 was partly driven by the privatization and liberalization wave in the Zimbabwean economy. This saw a substantial inflow of foreign capital, particularly from South African companies, into various sectors of the Zimbabwean economy. The sudden reversal of FDI inflow, coupled with falling domestic investment, had a depressing effect on GFCF, which fell from a record high of 24.6% of GDP in 1995 to only 2% of GDP by 2005. Since 2008, GFCF has shown sustained growth, reaching 22.4% in 2012 (see Figure 5).

Zimbabwe's FDI increased from US$52 million in 2008 to US$392 million in 2012, according to the latest statistics from UNCTAD. The growth in FDI followed the adoption of the multi-currency regime in 2009, which stabilized the economy. FDI has increased by 752% since 2008. Over the same period, GFCF showed similar growth.

During this period, Zimbabwe embarked on a reform agenda through the adoption of policies designed to attract FDI. These include the creation of a one-stop investment shop and the adoption of the *Medium Term Plan*[8] *2011–2015*. Zimbabwe is also harmonizing its indigenization and investment policies to improve FDI (see Boxes 4 and 5). To this end, Zimbabwe has undertaken numerous investment promotion tours to South Africa, Hong Kong, Dubai, Australia and Brazil – among others – as it intensifies efforts to attract FDI.

However, the subjective perception of the international community concerning Zimbabwe's ability to attract FDI ranks the country 132nd out of 148, according to a series of opinion polls by the World Economic Forum (2013). See also page 30.

7 GFCF consists in investment in land improvements (fences, ditches, drains and so on); plant, machinery and equipment purchases; and the construction of roads, railways and the like, including commercial and industrial buildings, offices, schools, hospitals and private residences.

8 Following the harmonized elections of 2013, the Ministry of Science and Technology Development was transformed into the Department of Science and Technology Development within the new Ministry of Higher and Tertiary Education, Science and Technology Development. The new government subsequently prepared the *Zimbabwe Agenda for Sustainable Socio-economic Transformation, 2013–2018* (ZimAsset, see page 17). ZimAsset replaces the *Medium Term Plan* 2011–2015.

Table 4: FDI inflow and outflow for Zimbabwe, 1990–2012

Year	FDI inflow [million current US $]	FDI outflow [million current US $]	FDI inflow/GFCF*
1990	n/a	12	-0.8
1991	3	n/a	0.2
1992	19	n/a	1.3
1993	38	n/a	2.4
1994	41	n/a	2.8
1995	118	n/a	6.7
1996	81	n/a	5.2
1997	135	28	8.7
1998	444	9	30.6
1999	59	9	6.7
2000	23	8	2.5
2001	4	4	10.5
2002	26	3	9.7
2003	4	0	0.4
2004	9	0	1.2
2005	103	1	13.5
2006	40	0	25.4
2007	69	3	26.4
2008	52	8	19.2
2009	105	0	15.2
2010	166	43	2.9
2011	387	14	18.7
2012	392	n/a	18.8

*gross fixed capital formation

Source: UNCTAD *World Investment Report* (s) [several years]

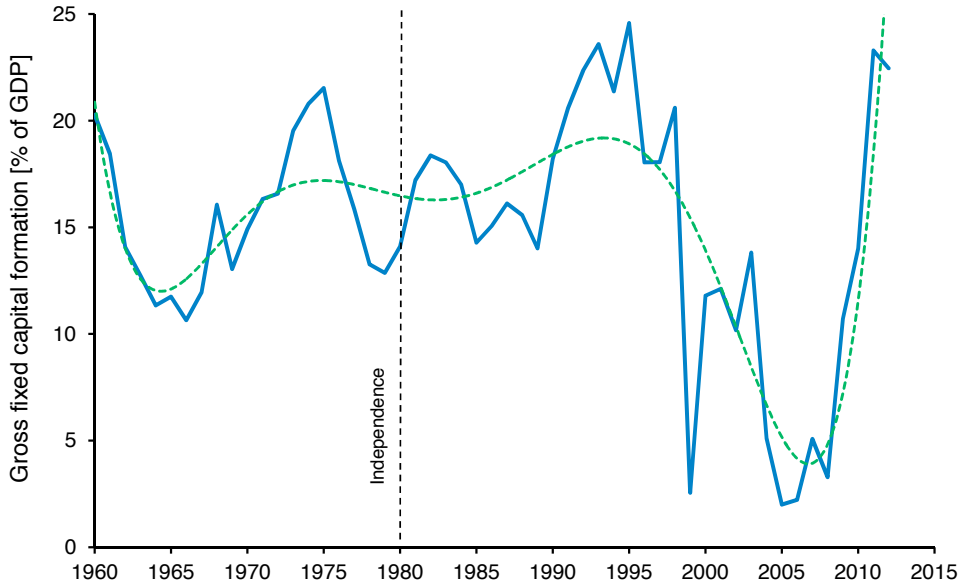


Figure 5: Evolution of gross fixed capital formation in Zimbabwe, expressed as a percentage of GDP, 1996–2013. The dotted line indicates the best fitting curve. Source: UNESCO, based on raw data provided by the World Bank

The potential of FDI for improving technical efficiency

In their study, Wang and Wong (2012) define technical efficiency as a country's ability to obtain maximum output from a given vector of inputs, so technical efficiency improvement refers to the movements toward the production frontier. They show that the inflow of foreign R&D transferred via FDI plays an important role in improving a country's technical efficiency. They have estimated the average technical efficiency scores for individual countries based on the value of the inflow of foreign R&D transferred via FDI. Based on their findings, Table 5 presents the evolution (1986–2007) in technical efficiency and scientific productivity for a selected group of sub-Saharan countries, including Zimbabwe (before the 2008 crisis). On average, technical efficiency increases over time for the majority of these countries, with the exception of Zambia and Zimbabwe, where it decreases.

Table 5: Average technical efficiency and scientific productivity in Zimbabwe, 1986–2007
Other countries are given for comparison

Country	Country technical efficiency								Scientific productivity		
	1986–1989	1990–1994	1995–1999	2000–2004	2005–2007	1986–2007	σ	τ	α	$b = \sum_{1986}^{2007} \frac{Pop}{\Delta t}$	$SCIP = A/(B x \Delta t)$
Botswana	0.755	0.763	0.802	0.895	0.934	0.824	0.077	22	2,066	1.61	58.33
Cameroon	0.449	0.403	0.471	0.598	0.670	0.508	0.100	22	4,680	14.65	14.52
Congo, Dem. Rep.			0.391	0.385	0.459	0.404	0.037	13	1,462	43.33	1.53
Gambia, The	0.391	0.413	0.411	0.477	0.542	0.441	0.054	22	1,156	1.13	46.50
Ghana	0.383	0.418	0.413	0.435	0.468	0.421	0.029	22	3,762	17.49	9.78
Kenya	0.701	0.704	0.698	0.681	0.732	0.701	0.025	22	13,441	28.70	21.29
Malawi	0.265	0.289	0.393	0.443	0.450	0.365	0.079	22	2,287	10.63	9.78
Mali	0.418	0.437	0.519	0.618	0.653	0.523	0.095	22	1,215	9.60	5.75
Mozambique	0.610	0.624	0.664	0.758	0.863	0.694	0.098	22	802	16.89	2.16
Senegal	0.562	0.556	0.587	0.635	0.656	0.596	0.041	22	3,010	9.11	15.02
South Africa	0.934	0.935	0.896	0.928	0.944	0.926	0.018	22	107,511	40.55	120.51
Togo	0.273	0.268	0.361	0.413	0.456	0.349	0.076	22	773	4.51	7.79
Uganda	0.510	0.478	0.578	0.651	0.712	0.584	0.089	20	3,656	22.17	7.50
Zambia	0.882	0.883	0.695	0.660	0.678	0.762	0.105	22	2,125	9.35	10.33
Zimbabwe	0.639	0.545	0.568	0.493	0.412	0.550	0.068	20	5,380	11.59	21.10

Note: In this table, *s* represents the standard deviation of the technical efficiency measurements; *t* indicates the total number of annual observations; *a* represents the total number of scientific publications listed by Web of Science between 1986 and 2007; *b* is the total average population between 1986 and 2007; *Dt* is the number of years between 1987 and 2007 and *SCIP* is the scientific productivity or the average number of scientific publications per million population between 1986 and 2007.

Source: UNESCO, based on data provided by Wang and Wong (2012), Web of Science and UN Statistics Division

As least developed countries may not have adequate domestic resources to promote the accumulation of R&D stock, the study by Wang and Wong (2012) suggests that adopting preferential policies to promote trade and capital flows which increase access to the results of foreign R&D can be extremely important for improving technical efficiency and, consequently, industrial competitiveness.

However, technical efficiency, innovation and competitiveness also depend on other variables, such as infrastructure and political stability. Arnold (2004) identified other factors, such as managerial deficits, a lack of technological understanding, learning ability or absorptive capacity to make use of externally generated technology, or a failure to (re)configure public institutions, such as universities or research institutes, so that they work effectively within the innovation system, or deficiencies in regulatory frameworks (e.g. health and

safety rules), as well as other indirect factors, such as the sophistication of demand or cultural and social values, all of which can have a negative effect on innovation and economic performance. Improvements in infrastructure and political stability, combined with adequate human capital policies, can help to improve a country's technical efficiency and attractiveness for FDI.

As least developed countries may not have adequate domestic resources to promote the accumulation of R&D stock, the study made by Wang and Wong (2012) suggests that adopting preferential policies to promote trade and capital flows which increase access to the results of foreign R&D can be extremely important for improving technical efficiency and, consequently, industrial competitiveness.

However, technical efficiency, innovation and competitiveness also depend on other variables, such as infrastructure and political stability. Arnold (2004) identified other factors, such as managerial deficits, a lack of technological understanding, learning ability or absorptive capacity to make use of externally generated technology, or a failure to (re)configure public institutions, such as universities or research institutes, so that they work effectively within the innovation system, or deficiencies in regulatory frameworks (e.g. health and safety rules), as well as other indirect factors, such as the sophistication of demand or cultural and social values, all of which can have a negative effect on innovation and economic performance. Improvements in infrastructure and political stability, combined with adequate human capital policies, can help to improve a country's technical efficiency and its attractiveness for FDI.

THE CORRELATION BETWEEN GOOD GOVERNANCE AND SCIENTIFIC PRODUCTIVITY

In an increasingly complex innovation landscape, developing effective governance requires better co-ordination at, and among, the local, regional, national and international levels. With the broadening of innovative processes, players and locations, the systems of governance that provide for their proper functioning become even more important. As no single actor has the knowledge and resources to tackle the innovation challenge unilaterally, all countries – in one way or another – face the task of better co-ordinating the various actors involved in formulating and implementing policy.

It goes without saying that institutions, politics and economics are central to any system of governance. Where controversy has sometimes arisen, it has concerned what constitutes good and bad governance and linking governance to democracy. The Zimbabwean discourse on governance has not escaped this controversy (UNDP, 2000). One survey in Zimbabwe discussed 'good governance' in terms of attaining a 'good society' characterized by positive relationships at all levels, based on equity, understanding, cooperation and mutual respect, respect for citizens' political, economic and social rights, fair distribution of resources, maximum development of individuals and communities, a strong and committed leadership, as well as peace and democracy (ACPDT, 2000).

Since 1996, the World Bank has published a set of standardized governance indicators each year for every country in the world. The World Bank's team defines governance as the traditions and institutions by which authority in a country is exercised. This includes the process by which governments are selected, monitored and replaced, the government's capacity to formulate and implement sound policies and respect on the part of both citizens and the state for the institutions that govern economic and social interactions (Kaufman *et al.*, 1999).

Within UNESCO's GO→SPIN programme, some correlations among these governance indicators and SETI productivity were found (Lemarchand, 2013). For example, in Figure 6, countries are represented in a Cartesian graph (four quadrants), according to their positive or negative values for government effectiveness and political stability/absence of violence. The size of the bubble reflects the number of scientific publications – listed by the Web of Science – per million population. Few nations fall in the first quadrant. Those countries with the largest GDP per capita and number of scientific publications per million

population are located in this first quadrant[9] (Lemarchand, 2013). The only African countries included in the first quadrant are Botswana, Cape Verde, Ghana, Mauritius, Namibia, Seychelles and South Africa (at the limit for positive values for political stability/absence of violence).

No African countries feature in the second quadrant (negative values for political stability/absence of violence but positive values for government effectiveness). The third quadrant (negative values for both indicators) concentrates the great majority of African countries. Figure 6 also shows that the smallest bubble size and, consequently, features the least productive countries in terms of scientific publications per capita. Lastly, 10 African countries fall in in the fourth quadrant (positive values for political stability/absence of violence but negative values for government effectiveness).

Figure 7 shows the evolution in these two governance indicators for Zimbabwe between 1996 and 2012. Both political stability/absence of violence and government effectiveness had negative values for the entire period.

During this period, governance evolved across the third quadrant, the relative distance of the bubbles to the origin of coordinates indicating how governance evolved (a shorter distance implies better governance). Consequently, governance in Zimbabwe deteriorated between 1996 and 2009 when it reached its lowest ebb. Since then, the governance indicators have begun improving, in spite of the fact that the country still has negative values for these two indicators. Figure 8 shows the evolution of these two combined governance indicators over time.

Corruption is another important variable – associated with the quality of governance – which has increasingly been incorporated in most of the regional and international reports published by international organizations, including the *African Economic Outlook* (ADB *et al.*, 2013). Since 1998, Transparency International has published the *Corruption Perceptions Index* (CPI). The CPI ranks countries and territories based on how corrupt their public sector is perceived to be, on a scale from 0 (highly corrupt) to 100 (very clean). A country's rank indicates its position relative to the other countries and territories listed in the index. The total number of countries included in the survey varies each year, ranging from 85 (1998) to 183 (2011). The CPI is calculated using data from 10 independent institutions. All 13 sources measure the overall extent of corruption (frequency and/or size of bribes) in the public and political spheres and all sources provide a ranking of countries[10].

9 The exception to the rule is Israel, which falls in the second quadrant.

10 To determine the mean value for a country, the data are standardized using the technique of matching percentiles. This method uses the country ranking reported by each individual source. It is useful for combining sources that have a different distribution. Whereas there is some information loss with this technique, it allows all reported scores to remain within the bounds of the CPI, i.e. between 0 and 100. A beta-transformation is then performed on scores. This increases the standard deviation among all countries included in the CPI and avoids a smaller standard deviation from year to year, one of the drawbacks of the matching percentiles technique. All of the standardized values for a country are then averaged, to determine a country's score. The CPI score and ranking are accompanied by the number of sources, high-low range, standard deviation and confidence range for each country. The confidence range is determined by a bootstrap (non-parametric) methodology, which allows inferences to be drawn from the underlying precision of the results. A 90% confidence range is then established, whereby there is a 5% probability that the value is either below or above this confidence range. Source: Transparency International (2013).

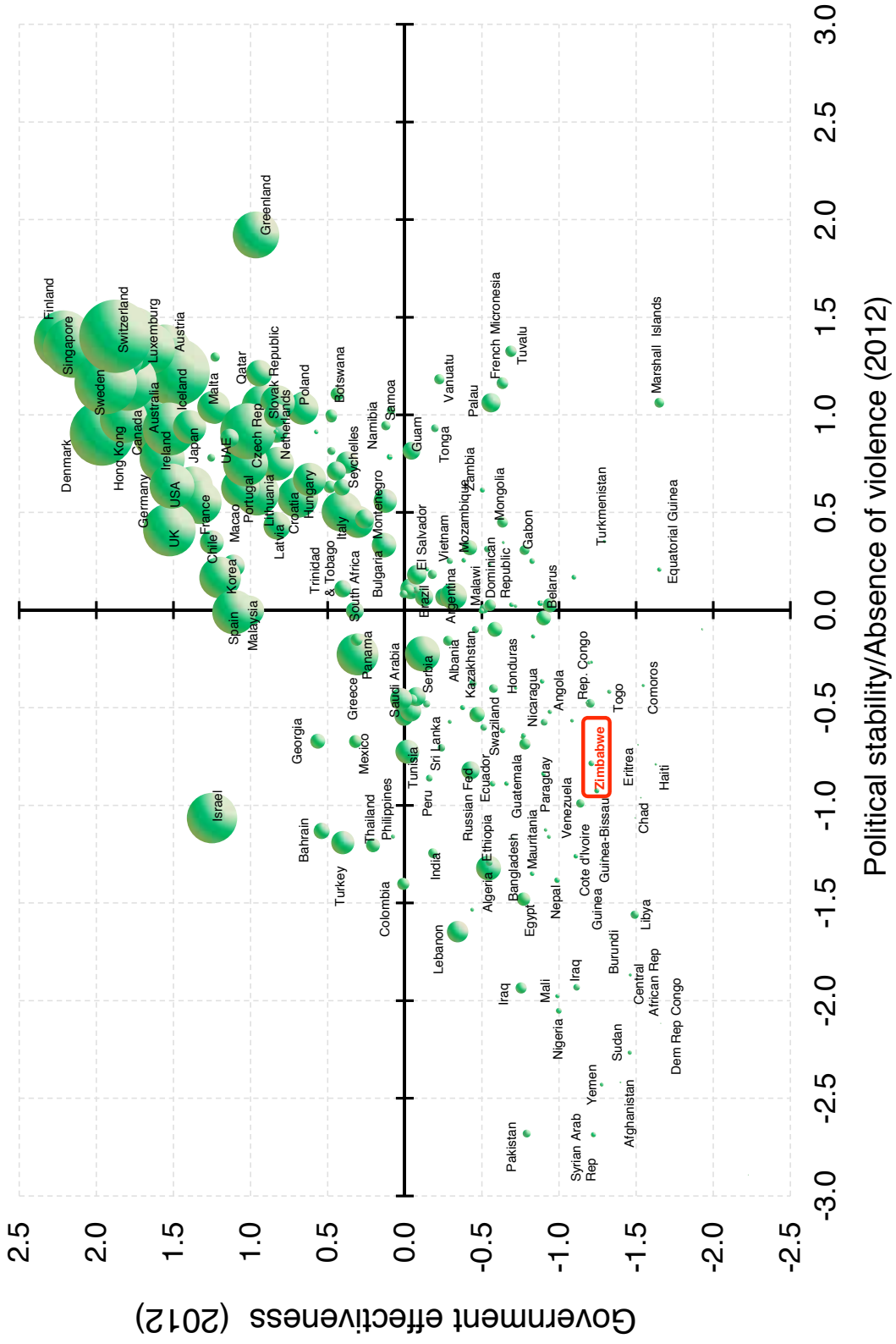


Figure 6: Evolution in government effectiveness worldwide, as measured against political stability/absence of violence, 1996–2012. The size of the bubbles reflects the number of scientific publications per million population for the same years. Zimbabwe appears in the third quadrant (in red). The majority of countries with high scientific productivity appear in the first quadrant (positive values for political stability/absence of violence and government effectiveness). Source: UNESCO, based on raw data provided by World Bank, UN Statistics Division and Web of Science

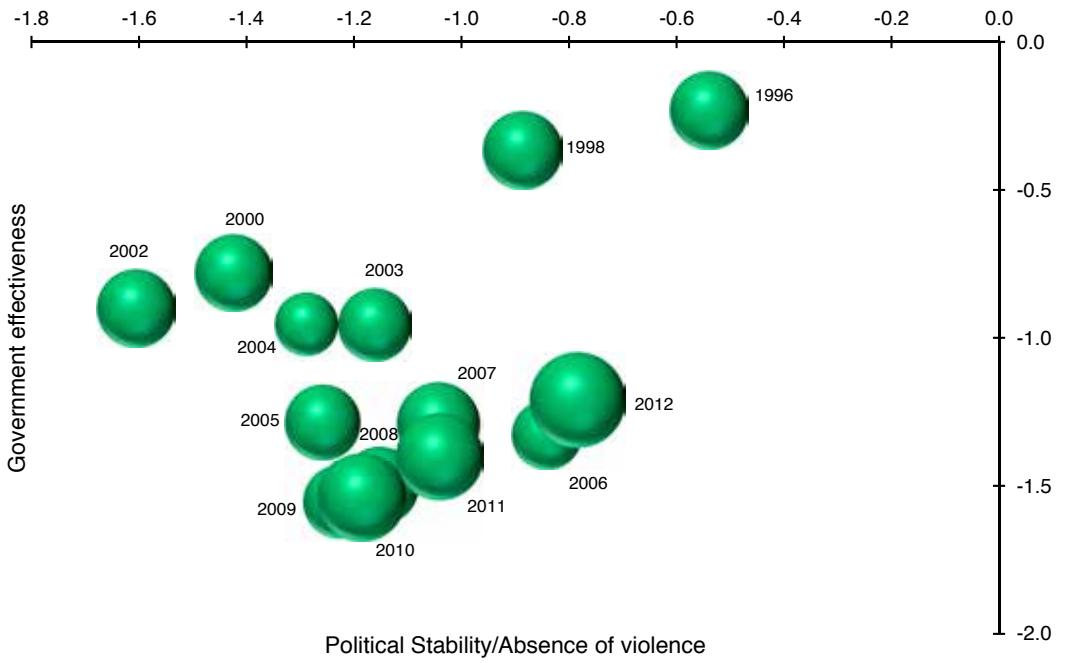


Figure 7: Evolution in government effectiveness in Zimbabwe, as measured against political stability/absence of violence, 1996–2012. The size of the bubbles reflects the number of scientific publications per million population for the same years. Source: UNESCO, based on raw data provided by the World Bank, UN Statistics Division and Web of Science

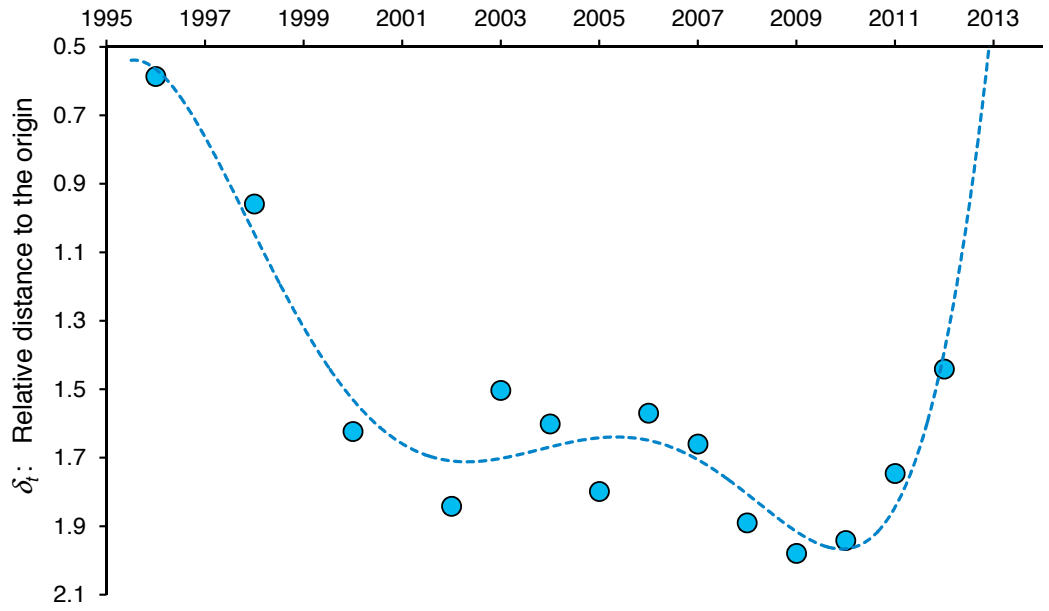


Figure 8: Evolution of the two combined governance indicators represented in Figure 7, 1996–2012. Here, the relative distance to the centre of the origin of coordinates is plotted over time. Since all the circles in Figure 7 fall in the third quadrant, these shorter distances mean a better level of governance. The dotted line is the best-fitting curve. It shows that Zimbabwe's combined governance indicators deteriorated until 2009 when the negative slope reversed. The relative distance δ_t at time *t* (year or measurement) is estimated as $\delta_t = \sqrt{G_t^2 + P_t^2}$ where G_t is the value for *government effectiveness* at year *t* and *Pt* is the value of p*olitical stability/absence of violence* at year *t*. Source: UNESCO

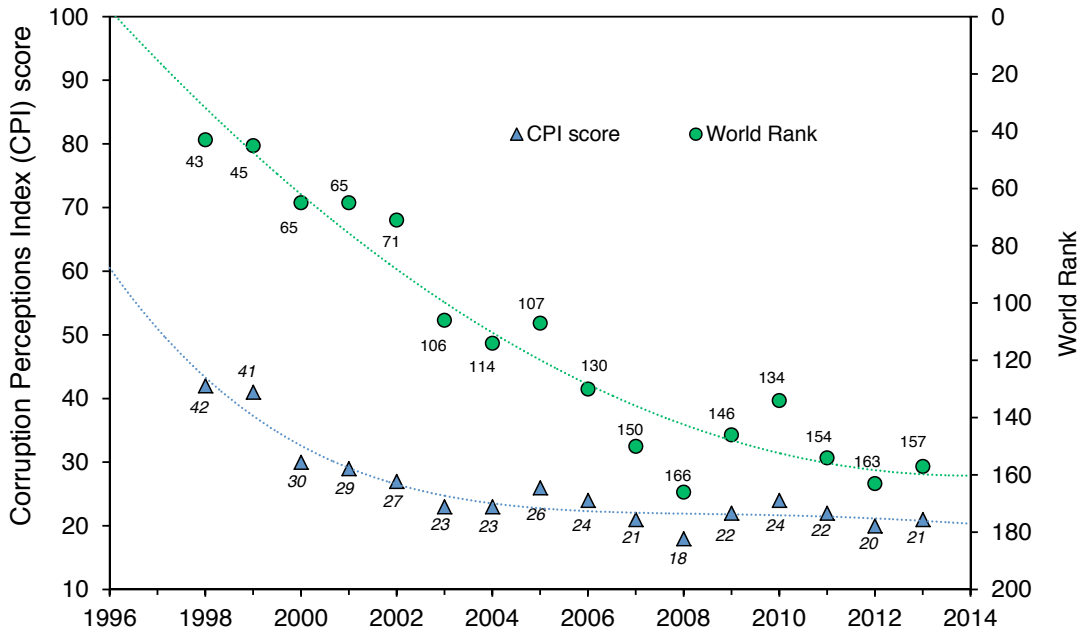


Figure 9: Evolution of the Corruption Perceptions Index (CPI) in Zimbabwe (triangles associated with the left-axis) and world rank (circles associated with the right-axis), (1998–2013). The dotted lines represent the best-fitting curves. Source: UNESCO, based on raw data generated by Transparency International

Figure 9 shows the CPI scores of Zimbabwe and its corresponding world ranking between 1998 and 2013. The shape of these curves follows a similar pattern to that for the governance indicators (Figure 8). In 1998, Zimbabwe ranked 45th (out of 85 countries). The same year, the country received record FDI of US$444 million. By contrast, in 2008, at the height of the economic crisis, the country ranked 166th (out of 180 countries), its lowest score, and FDI amounted to only US$52 million.

Weak governance is often a source of persistent failure in the application of public policies to development. Zimbabwe shows a high correlation between the evolution in its governance indices and the trends observed for other indicators, including: its human development index (Figure 2), life expectancy at birth (Figure 3), GDP per capita (Figure 4), gross fixed capital formation (Figure 5), foreign direct investment (Table 4), the country's technical efficiency (Table 5) and the production of scientific papers (Figure 24).

Political stability and good governance sustained over decades are prerequisites for developing sound public policies. Stability and predictability are particularly important for research and innovation, since both endeavours involve risk-taking with long time horizons. They thus require a stable framework, institutions and policies. Political instability may inhibit innovation by increasing uncertainty for innovators and venture capitalists; it may lessen the effectiveness of SETI policy instruments by weakening the incentives they provide. Moreover, research and innovation are cross-cutting activities that involve the ministries of science and technology, higher education, health, agriculture, energy, mining, environment, water and planning, etc. To be effective, research and innovation require co-ordination and coherence among government departments, programmes and policies; empirical studies over the past two decades show that governments find this difficult, since their traditionally departmentalized structures are generally ill-suited to deal with cross-cutting policy issues such as research and innovation. The way STI are managed in Zimbabwe by different ministries, universities and research centres which interact little is an example of this. Adopting a coherent approach entails not only co-ordinating a multitude of policy moves dictated by the core set of research and innovation policies, such as those for higher education and entrepreneurship, but also evaluating their possible interaction with policies pursuing other primary objectives, such as tax policy, competition laws and regulations which provide the framework for innovation (OECD, 2010).

CONSTRUCTING AN INNOVATION PROFILE: INDUSTRIAL POLICIES AND DEMAND FOR SETI

The national innovation systems paradigm usually characterizes the relationship among institutions that support and foster knowledge creation and the firms that exploit this knowledge. This stream of work suggests that institutions within a country need to complement each other and work in tandem to maximize innovation. It is argued that technology policy, which creates efficient institutional mechanisms for integrating the functions of knowledge production and knowledge commercialization, is likely to enhance a country's ability to sustain an innovative technology system over time (Stern *et al.*, 2002).

Innovation policy is usually defined as a set of policy instruments and appropriate institutions that assist in the local generation of technology and the introduction new products and services to the market. This may include adapting imported technologies to local conditions. Appropriate technology policies can be derived only from an understanding of how technical change takes place at the level of the enterprise. Whereas companies everywhere have to make an effort to master or adapt existing technologies, a high level of basic knowledge and capabilities exists in most firms in mature industrial countries, or can be easily acquired from other firms, labour markets, support institutions or consultants. This makes it relatively easy and routine to master existing technologies. In developing countries, by contrast, not only is the internal knowledge base for mastering technologies relatively weak; the support network provided by other enterprises, institutions and human capital also tends to be underdeveloped (Lall and Teubal, 1998).

The promotion of innovation at firm level includes the participation of representatives from the public and private sectors (e.g. entrepreneurs, researchers, public servants, financiers, etc.); some ventures may also include actors from civil society. The successful launch and running of initiatives involving innovation require aligning the interests of all stakeholders. This, in turn, implies a difficult coordination process. Among all stakeholders, the state appears best-placed for the role of initiating, guiding or facilitating coordination, owing to its stronger convening and coordinating power. Its major role is to set up appropriate policy instruments and incentives to change the behaviour of the different social actors involved in the innovation process. The public sector plays the fundamental role of aligning different incentives with different stakeholders, establishing risk-sharing mechanisms for multi-stakeholder ventures and promoting knowledge-sharing and dissemination. In developing countries, the lack of adequate public policies to promote co-ordination among different stakeholders is the major source of failure in promoting new innovative firms.

The productive units in a country constitute the SETI demand side. The characteristics and behaviour of demand for SETI over time determine whether or not it is possible to use the results of research obtained by universities and research centres (SETI supply side) to generate innovation and introduce new products and services to the market. To handle new knowledge and its incorporation into production, the productive unit has to make a number of technological decisions. Some are clearly concerned with the choice of alternatives regarding the source of new knowledge, the source of equipment and the use of such inputs. Others have to do with the building-up of the firm's capacity (technical and design groups, administrative organization, information) to make such choices, adapt foreign technology and incorporate new knowledge effectively into production. The adaptation of foreign technology is particularly important, since it contributes to the optimal use of foreign technology and can link foreign technology to domestic S&T.

The lack of adequate information about the characteristics and potentialities of the SETI supply and demand sides in a given country is a source of failure for research and innovation policies, policy instruments and incentives.

The Zimbabwe Academy of Sciences has recognized that the country's industrialization requires a national vision as to which specific materials should be targeted to obtain added value. This vision should be accompanied by the identification of specific technological skills, equipment and infrastructure required by the targeted industrial areas to accompany the process of value addition (Chetsanga *et al.*, 2009).

Zimbabwe has an agro-based economy, with a growing mining sector (platinum[11], diamonds, tantalite, silicon, gold, coal, coal-bed, methane, among others). Cletsanaga *et al.* (2009) determined that skills development for value addition was needed in these areas, backed by matching equipment and appropriate SETI policy instruments.

On the SETI demand side, the major sources of information are innovation surveys (RICYT, 2001; OECD, 2005, 2010). In 2014, the UNESCO Institute for Statistics was analysing the findings of a new global survey of innovation. In 2009, the Zimbabwe Academy of Sciences elaborated a draft for a survey of science, technology and innovation (Chetsanga *et al.*, 2009).

In recent years, a growing number of surveys have studied the behaviour of entrepreneurship and innovation in different countries. Some of these provide valuable information on Zimbabwe (CZI, 2013; World Economic Forum, 2014; INSEAD *et al.*, 2013). See Table 6 for a series of subjective and objective indicators showing the perception of research and innovation in Zimbabwe.

Figure 10 shows the results of the executive poll designed to determine the major difficulties faced by the productive sector in promoting innovation and increasing competitiveness. It is clear that lack of finance is a major factor, as are policy instability and inadequate infrastructure. These results are consistent with those obtained in a recent survey of the manufacturing sector conducted by the Confederation of Zimbabwe Industries (see next section).

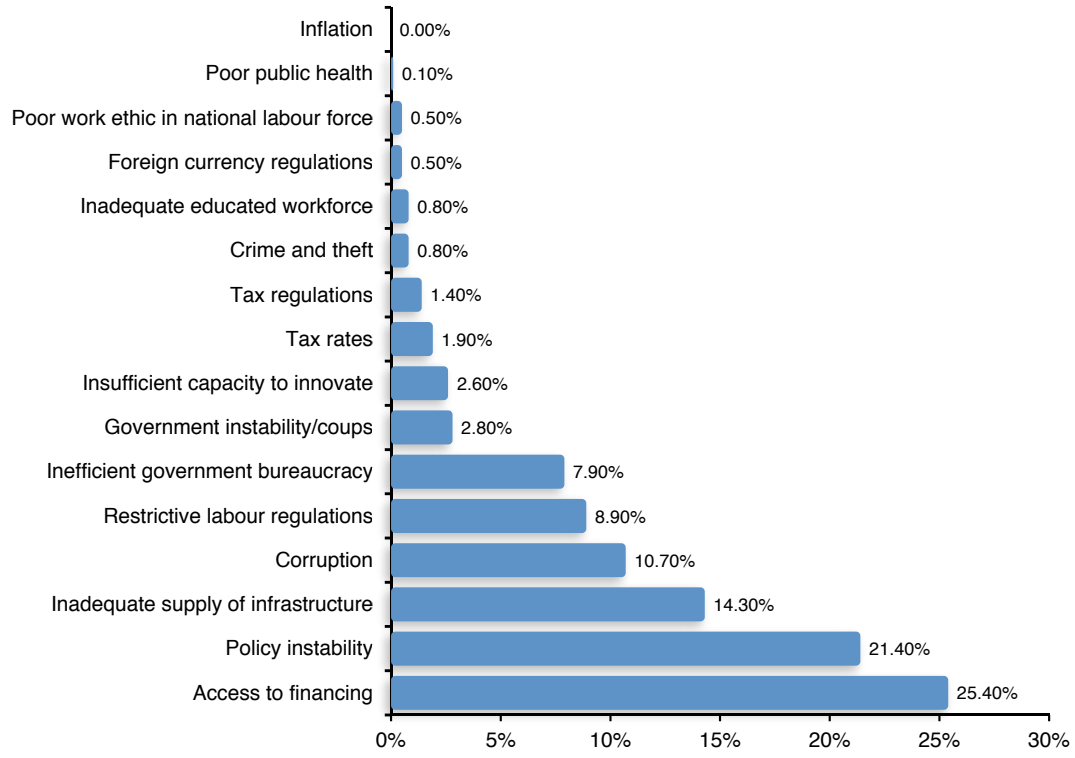


Figure 10: Major difficulties in promoting innovation and competitiveness in Zimbabwe, 2013. Source: World Economic Forum (2014)

11 Zimbabwe has the second-largest reserves of platinum in the world.

Table 6: Selected subjective and objective measurements for Zimbabwe

Subjective index: World Economic Forum Executive Opinion Survey 2013 (Max. value = 7)			Objective Measurements		
Indicator	Value 1–7	Rank out of 148	Indicator	Value	Rank out of 148
Quality of the education system	4.3	42	Secondary enrolment, gross % (2011)	38.0	131
Quality of Math and Science Education	4.2	63	Tertiary education enrolment, gross % (2011)	6.0	130
Quality of management school	4.1	81	School life expectancy in years (2011)	11.3	101
Internet access in schools	3.0	119	Individuals using internet, % (2012)	17.1	109
Availability of research and training services	3.7	105	Broadband internet subscriptions/100 population (2012)	0.5	114
Extent of staff training	3.9	82	Int'l internet bandwidth, kb/s per user (2012)	3.3	125
Availability of latest technology	4.4	103	Mobile broadband subscriptions/100 population (2012)	29.7	54
Firm level technology absorption	4.3	99	Mobile telephone subscriptions/100 population (2012)	96.9	97
FDI and technology transfer	3.6	132	Fixed telephone lines/100 pop (2012)	2.3	119
Capacity for innovation	2.9	122	Number of applications filed under the Patent Cooperation Treaty per million population (2010)	0.1	98
Quality of scientific research institutions	3.1	109	Scientific articles listed at SCOPUS (2012)	373	106
Company spending on R&D	2.4	133	Citable scientific articles-H index (2012)	72	91
University-industry collaboration in R&D	3.1	112	Life expectancy at birth in years (2011)	51.2	140
Government procurement of advanced tech products	2.6	137	Women in labour force, ratio to men (2010)	0.9	19
Availability of scientists and engineers	3.5	109	Imports as a % of GDP (2012)	61.9	40

Note: The subjective indicators (from a low of 1 to a high of 7) are based on a series of executive opinion surveys prepared by the World Economic Forum, whereas the objective indicators (related to research and innovation) were originally produced by other agencies and have been compiled by the World Economic Forum. Both columns show Zimbabwe's ranking out of 148 nations for each individual indicator. Similar surveys and data have also been produced by INSEAD *et al.* (2013).

Source: World Economic Forum (2013) *Global Competitiveness Report* (2013–2014)

SURVEYING THE MANUFACTURING SECTOR

The annual manufacturing sector surveys conducted by the Confederation of Zimbabwe Industries between 2009 and 2013 provide a unique insight into the economy from the business perspective. The results of the 2013 survey show that, after a rebound in manufacturing in 2009, growth is now fading. The slow-down being experienced by the economy at large has not spared the manufacturing sector.

A firm's productive capacity is the total level of output, or production, that it can potentially produce over a given period; capacity utilization is the percentage of a firm's total productive capacity that is effectively being used. Factors which may impinge on a company's capacity utilization include electricity charges, access to finance, public-sector bureaucracy (see Table 7).

In 2013, the average capacity utilization pursued its downward spiral, shedding 5.3 percentage points over a 12-month period to 39.6%. Only 35.7% of respondents recorded capacity utilization above 50%, with only two firms recording a capacity of 100%. Table 8 shows the levels of capacity utilization in manufacturing by sub-sector.

Table 7: Factors affecting business in Zimbabwe, 2013

Factor	Very Positive	Positive	No effect	Negative	Very negative
Minimum wages	2	9	26	40	13
Restricted labour regulations	2	4	37	39	18
Political instability	2	9	36	40	13
Corruption	2	3	14	44	38
Power cuts	2	9	36	40	13
Electricity charges	1	4	4	46	44
Access to finance	2	9	36	40	13
Domestic demand	2	26	7	38	27
Public sector bureaucracy	2	9	36	40	13
Environmental management Agency (EMA) requirements	2	10	48	22	18
Interest rates	2	9	36	40	13
Exchange rate	2	9	54	22	13
Insufficient capacity to innovate	2	9	36	40	13
Ageing equipment	1	2	13	44	29
Competition from imports	2	9	36	40	13
Cash shortages	2	3	41	41	15
Bank system instability	2	10	29	45	14

Source: CZI (2013) Manufacturing Sector Survey

Manufacturing export sales increased from 15% to 20% of total turnover between 2012 and 2013. Zambia remains the top export destination for Zimbabwe's manufactured goods, receiving 31% of the total. South Africa's market share has increased from 12% to 18% of the total, when, traditionally, South Africa used to be Zimbabwe's top trading partner. Today, South Africa tops the list of competing imported products, with 85% of respondents indicating that they compete with South African products. In comparison, 67 % of competing products come from China.

The general view of respondents is that the lack of long-term financing continues to hinder any meaningful development in the manufacturing sector. Since 2009, industry has been plagued by the same factors. The situation is now dire and in need of urgent redress. The perceived current state of economic uncertainty and the period of political uncertainty leading up to the elections have dampened investor confidence at a time when industry needs an injection of capital. Only 40% of respondents had made a capital investment in 2013 and even this was used mainly to buy equipment and machinery – only 5% of these funds came from FDI.

Innovation and capital investment

Six out of ten respondents did not make any capital investment at all in 2013. Of those who did, 90% had invested in machinery and equipment and the remainder in land and buildings. The main motivation was to replace worn-out machinery and equipment (47%) but 43% indicated a desire to expand their operations.

The lack of available capital is a critical issue that has been discussed widely. Figure 11 shows that the main sources of funding for capital investment were essentially the same in 2012 and 2013, 59% of respondents stating that they had ploughed their profits back into the company in 2013.

Obtaining staff with the right skills for the market

The CZI survey provided valuable insights into industry's perception of the type of professionals that the higher education sector is producing in Zimbabwe. Figure 12 shows the results of the survey regarding the suitability of the tertiary curriculum.

Collaboration with universities ensures that tertiary institutions produce the right human capital for the market. Most respondents to the CZI survey indicate that they do not collaborate with tertiary institutions but point out that the curricula offered by these institutions are moderately relevant for companies. Figure 13 shows the distribution of opinion among industrials regarding collaboration with the university sector in Zimbabwe.

Table 8: Average capacity utilization by subsector in Zimbabwe, 2013

Manufacturing subsector	Average capacity utilization of industry (%)	
	2012	2013
Bakers	40.0	82.5
Batteries	76.5	71.5
Building (construction and related)	59.5	44.1
Car assemblers	30.3	13.1
Electric appliance manufacturers	43.8	37.5
Engineering iron and steel	36.7	27.7
Food, dairy and beverages	58.2	42.0
Grain millers	30.0	50.0
Chemical	41.6	30.0
Leather and allied	27.5	11.3
Pharmaceuticals	58.0	20.0
Plastic, packaging and rubber	46.1	38.0
Paper, printing and publishing	58.3	55.0
Textiles and clothing	34.4	35.3
Timber processors	53.8	58.0

Source: CZI (2013) Manufacturing Sector Survey

INSEAD *et al.* (2013) made a systematic analysis of the major components of innovation in 142 countries. The study analyses seven pillars (business sophistication; creative output; human capital and research; infrastructure; institutions; knowledge and technology output and market sophistication Figure 14 shows the cartographic results obtained by Zimbabwe for each individual pillar. In 2013, Zimbabwe came 132nd out of 142 countries, with an integrate value of 24 out of 100 maximum points.

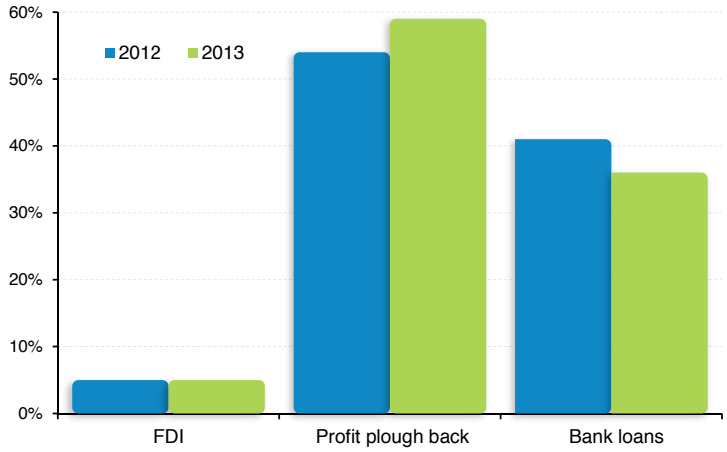


Figure 11: Sources of funding for capital investment in Zimbabwean industry, 2012 and 2013. Source: CZI (2013) *Manufacturing Sector Survey*

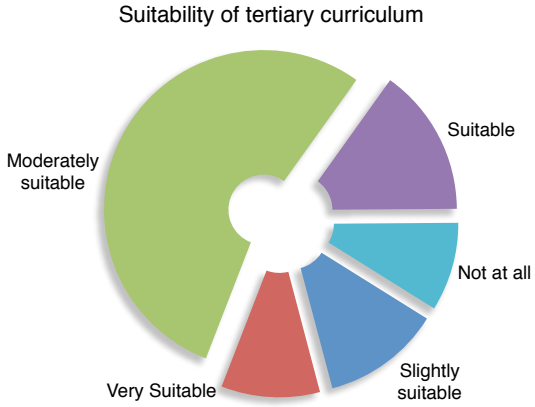


Figure 12: Results of the poll on the suitability of the tertiary curriculum. Source: CZI (2013) *Manufacturing Sector Survey*

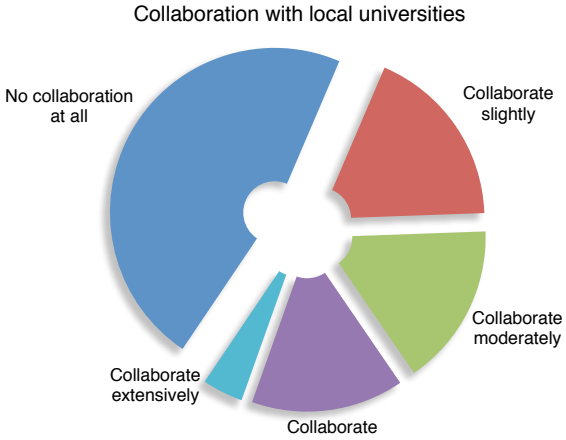


Figure 13: Results of the poll on collaboration with local universities. Source: CZI (2013) *Manufacturing Sector Survey*

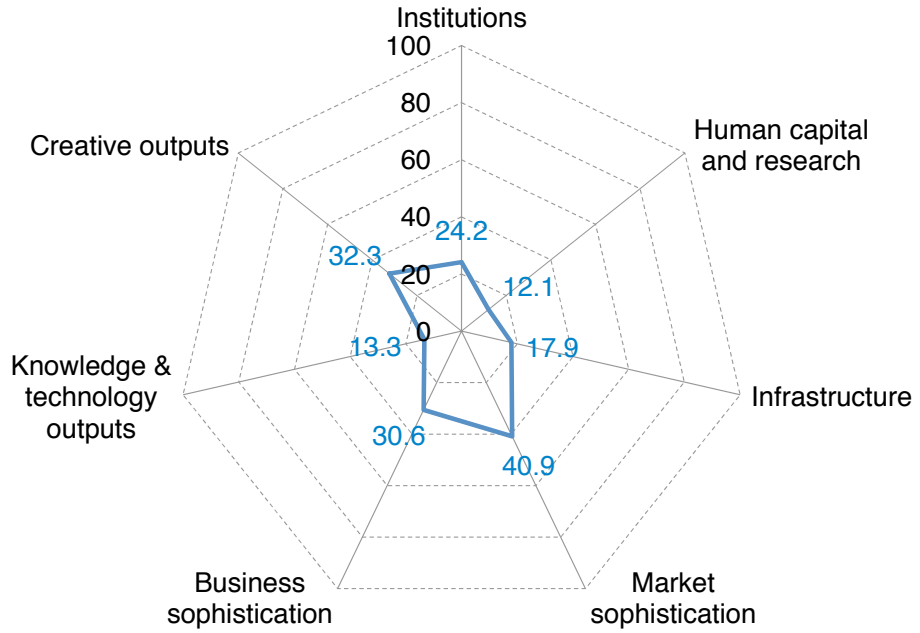


Figure 14: Zimbabwe's scores (0–100) for each individual pillar, taking into account the estimation of the *Global Innovation Index*. Source: INSEAD *et al*, (2013)

BOX 5 – RESEARCH AND INNOVATION IN ZIMBABWE'S INDUSTRIAL DEVELOPMENT POLICY, 2012–2016

> *Zimbabwe's industrial development will also benefit from human capacity building, investment in health, education and training. In today's knowledge-based global economy, industrialization is increasingly being driven by scientific research, technology and innovation. The ability to develop, acquire, upgrade and adapt technologies is a key element for competing effectively in the global market. Thus, there must be continuous flows of scientific discoveries and the development and adaptation of technologies to ensure improvement in the competitive production of Zimbabwe's industrial goods in the regional and international markets.*
>
> *His Excellency, R. G. Mugabe, President of the Republic of Zimbabwe*

Introductory remarks to the *Industrial Development Policy*, 2012–2016

Recently, a new *Industrial Development Policy* (2012–2016) was established in Zimbabwe. The vision of the policy is to transform Zimbabwe from a producer of primary goods into a producer of processed value-added goods for both the domestic and export markets. The policy mission statement proposes creating a vibrant, self-sustaining and competitive economy through the promotion of viable industrial and commercial sectors, as well as via domestic and international trade.

The overall policy objective is to restore the manufacturing sector's contribution to GDP by 2015 from the current 15% to 30% and its contribution to exports from 26% to 50%. This is consistent with the *Medium-Term Plan for 2011–2015*. Average real GDP growth of 7% is targeted under the policy framework for 2012–2016. The policy proposes: (a) the creation of additional employment in the manufacturing sector on an incremental basis and reduced unemployment levels by 2016; (b) increasing capacity utilization from the current level of around 57% to 80% by the end of the planning period; (c) re-equipping and replacing obsolete machinery and new technologies for import substitution and enhanced value addition; (d) increasing manufactured exports to

the Southern African Development Community (SADC) and Common Market for Eastern and Southern Africa (COMESA), as well as to the rest of the world and (e) promoting utilization of available local raw materials in the production of goods.

The research and innovation components of the *Industrial Development Policy* of Zimbabwe are included in the following excerpts:

Assumptions

1.4.1.7 Creating and strengthening national capacity for innovation and the effective application of science and technology in industry.

Technology transfer and research and development

3.8.1 This principle is a key success factor for a competitive and vibrant industry for attaining the set export targets of the Industrial Development Policy *and* Medium Term Plan, *which envisage exports to grow by 50% over the plan period. The current stocks of capital equipment are not able to meet the export target as studies have revealed that there is need in some sectors such as the tyre industry for an overhaul of capital equipment to match the global technology and developments and improvements.*

3.8.2 In addition, it is also proposed that industry invests in research and development on new processes and products which will result in competitive and cost effective products. It is therefore proposed that Technology Transfer be incorporated into the Industrial Developing Policy document as a central element not only to ensure growth and development, but more critically to attain global competitiveness of our goods and services and also facilitate private sector participation to enhance commercialization of research and development from the academia, through increased public private partnerships for research, development and innovation.

3.8.3 Greater financial support for innovation and technology is necessary in order to contribute to the national target of increasing and sustaining research and development expenditure to 2% of GDP.

3.8.4 Technology transfer and research and development shall be pursued in a manner that ensures efficient resource utilization and environmental sustainability. This will be done through encouraging industrial establishments to use technologies that minimize industrial emissions, the discharge of solid waste and improve waste water management and introduce and strengthen cleaner production techniques and work practices in industrial processes by industrial operators including plastic waste management.

Prioritizing sectors

4.1.6 While Government will source short term financing in order to facilitate the above mentioned prioritized sectors, the private sector is also urged to contribute meaningfully to its operations through sourcing additional resources on its own. Government will also source funding for research and development, technology transfer and skills development in these sectors.

4.7.2 (Pharmaceuticals) The sector has a highly trained labour pool and produces high quality drugs which are competitive on the export market. It also boasts of modern production methods. There are great investment opportunities in the production of medicinal, veterinary and skin products. Research and development in the sector will also enhance the utilization of locally available resources.

Small and medium enterprises support

5.10.3 Other strategies to be adopted by Government during this period include Infrastructural Support; Technology Upgrades; Quality Control and Improvement; Research and development, Market access and Financing Facilities.

Source: Industrial Development Policy, 2012–2016 (Republic of Zimbabwe, 2012c)

NATIONAL POLICIES TO PROMOTE GREEN PRODUCTION OF GOODS AND SERVICES

Many companies in Zimbabwe are managing their waste voluntarily by using best practices to meet the requirements of the International Standards Organisation (ISO) 14000 series certification. The ISO accreditation requires companies to create and implement environmental management systems. These systems require the company firstly to have an environmental policy that commits the organization to continual improvement, prevention of pollution and compliance with all relevant environmental legislation and regulations. In Zimbabwe, about 30 companies have established ISO 14001 certified environmental management systems (Feresu, 2010).

There are a number of companies implementing a variety of 'green' activities in Zimbabwe, such as waste management, pollution control, energy management, water management, cleaner production/green manufacturing, material/resource conservation and environmental management.

The United Nations Environmental Programme (UNEP) has developed a *Cleaner Production Manual* which is used by its cleaner production centres all over the world. The Cleaner Production Centre in Zimbabwe has assessed more than 50 companies in Zimbabwe using this methodology. The Department of Mechanical Engineering at the University of Zimbabwe has conducted more than 30 cleaner production assessments of Zimbabwean companies. Some companies have taken action based on these assessments. However, many have been unable to implement costly measures, owing to the current economic and financial difficulties they face.

Zimbabwean companies have operated under obsolete environmental laws, by-laws and regulations for a long time. Most of the environmental laws were enacted between 1946 and 1982 and need urgent updating. The city councils, town councils and rural district councils in Zimbabwe have ineffective legislation and enforcement capabilities. The discharge of effluent in urban areas is loosely controlled. Furthermore, law enforcement should be more effective. Procedures are essentially restricted to the issuance of repeated memoranda and warnings, while the pollution continues unabated. Fines are rarely implemented and even these are for negligible sums, since most have not been updated since 1980. In real terms, fines in the 1970s were about 100 times those in place now (Mbohwa, 2002).

The Environmental Management Act is the major policy for promoting cleaner production of goods and services. It states that, 'if any other law is in conflict or inconsistent with this act, this act shall prevail.' Prior to 2002, environmental legislation was fragmented and unco-ordinated. The Environmental Management Act (2002) took a holistic approach to environmental management, considering that the biophysical, socio-economic, technological and political aspects were all linked and that sustainable development needed to place 'people and their needs at the forefront of concern,' including by promoting 'the participation of all interested and affected parties in environmental governance'.

The Environmental Management Act made provisions for the establishment of an Environmental Management Agency to co-ordinate actors in the environment sector ranging from government departments to civil society and the private sector. The act established a supreme body, the National Environmental Council, to provide overall policy guidance and provide directions for the implementation of the act. It also made provisions for an Environment Fund and for preparing a National Environmental Plan and others for the management and protection of the environment.

The Environmental Management Agency[12] has been operational since March 2003. It is responsible for formulating quality standards and monitoring the observance of these, including via inspections and law enforcement. All local authorities are required to introduce environment action plans. Environmental impact assessments and state of the environment reporting are now mandatory. The agency has drafted regulations on a variety of topics that include effluent and solid waste disposal (2007), ecosystem protection

12 See www.ema.co.zw

(2007), hazardous waste management (2007), air pollution control (2009) and plastic packaging and plastic bottles (2009). On the page hosted by the agency on each regulation, comments sent in by Internauts are displayed.

The Environmental Council consists of the Permanent Secretariats of relevant government ministries, such as agriculture, education, energy, environment , forestry, mining, finance, health, industry, water resources, justice, local government and tourism), representative from universities, specialized research institutions, the business community, local non-governmental organizations and any other members co-opted by the council.

Following a consultative process between 2002 and 2004, a National Environment Policy was finalized.

The Ministry of Environment and Tourism became the Ministry of Environment, Water and Climate in 2013. The new ministry is in the process of drafting a strategic plan that is in line with the Zimbabwe Agenda for Sustainable Socio-Economic Transformation (see page 17).

BOX 6 – ZIMBABWE AGRICULTURAL INVESTMENT PLAN, 2013–2017

Agriculture is one of Zimbabwe's major fields of research and also one of the oldest (see Figures 19 and 20). As early as 1903, the Department of Agriculture became the country's first research institution. In 1948, the Department of Research and Special Services was founded. Today, it falls under the Ministry of Agriculture, Mechanisation and Irrigation Development and is one of the most important agricultural research bodies in Zimbabwe, with about half of the country's total number of full-time equivalent (FTE) researchers. Its research mandate encompasses virtually all aspects of crop and livestock production, with the exception of tobacco, sugar, pigs, agricultural engineering and animal health.

Zimbabwe's *Medium Term Plan 2011–2015* recognizes that agricultural research for development should be demand-driven and cover the entire commodity chain. This will entail restoring the capacity of national agricultural research systems and building new capacities for R&D by producing enhanced technologies and ensuring more of these are adopted by farmers.

In order to restore Zimbabwe's reputation as the 'bread basket of Southern Africa' and major exporter of agricultural products, the *Zimbabwe Agricultural Investment Plan: 2013–2017* (Republic of Zimbabwe, 2013a) was developed. It focuses on building the capacity of Zimbabwean farmers, service institutions and private enterprises to scale up production of commodities that have the biggest potential for growth and thus for having an impact on agricultural GDP. These goals will be reached through greater investment, institutional reforms and policy alignment. One of its major goals is to incorporate new technologies, drive innovation and add value to agribusiness.

In view of the fact that farmers are spread across Zimbabwe's five agro-ecological regions and need to compete in domestic and regional markets, the *Zimbabwe Agricultural Investment Plan* will promote crop and livestock production, based on the comparative advantage of each region, such as livestock in Matabeleland, horticulture and timber in Manicaland, etc. Those products with significant potential for adding value downstream will be especially promoted, as they could increase the commodity's contribution to agriculture GDP significantly.

There are four 'intermediate result areas' in the *Zimbabwe Agricultural Investment Plan* that have been identified as individually and collectively contributing to the overall programme objective: (1) Increasing production and productivity through improved management and sustainable use of land, water, forestry and wildlife resources; (2) increased participation of farmers in domestic and export markets though development of an efficient agricultural marketing system and an enabling environment for competitive agricultural production investment and trade; (3) ensuring food and nutrition security by facilitating a cohesive multi-sectoral agricultural response and (4) improving agricultural research, technology dissemination and adoption.

EDUCATION PROFILE AND HUMAN CAPITAL FOR SCIENCE AND ENGINEERING

Investment in human capital via education is a major tool for sustainable development. Education is recognized the world over as a fundamental and universal human right and a prerequisite for economic growth, human development and poverty reduction. It enables the population to make informed decisions about its economic, social and political well-being. Education is important for protecting children from exploitative labour practices and is the most empowering tool for gender equality and equity. In addition to being the second United Nations Millennium Development Goal, universal access to primary education by 2015 is one of the goals of the Education for All by 2015 programme led by UNESCO and of UNICEF's agenda for A World Fit for Children by 2010.

From independence in 1980 until the early 1990s, Zimbabwe's education system was the envy of Africa. Today, the system is in danger of failing to meet the Millennium Development Goal of ensuring that, by 2015, all Zimbabwean girls and boys are able to complete a full programme of primary education. The unavailability of teaching materials and essential infrastructure, especially in marginalized rural areas, is a challenge. In primary schools, the pupil–textbook ratios for English and mathematics are 3:1 and 6:1 respectively and a similar challenge exists at secondary school level. This is the national average; the pupil–textbook ratio is even worse in rural schools (Republic of Zimbabwe, 2011).

Furthermore, the high proportion of children lacking access to early childhood development, the high numbers of school dropouts, especially among girls at higher levels, and the low pass rates, are all a cause for concern. In 2006, a total of 30 359 primary school pupils dropped out of school. The same year, a total of 21 190 pupils dropped out of secondary school, 51% of whom were girls. Since 2000, the pupil–teacher ratio has been 38:1, whereas the net enrolment ratio has declined from 99% in 2000 to 91% in 2009. Literacy rates in Zimbabwe are very high. The 2012 Census showed that 615 136 inhabitants (325 871 of them female) over the age of 15 never received formal education (ZIMSTAT, 2012: page 79). Table 9 shows the share of the population that has ever attended school, according to the findings of the most recent census (ZIMSTAT, 2013). Table 10 shows the current distribution of students (3–24 years) enrolled in the different levels of education. Table 11 presents data on the number of Zimbabweans aged 20 years and over who have completed the secondary and tertiary levels of education.

Table 9: Percentage of Zimbabwean population having ever attended school, by age group and sex, 2012

Age Group (years)	Male	Female	Total
3–4	18.5	19.5	19.0
5–9	86.6	87.9	87.0
10–14	98.8	98.8	98.9
15–19	98.2	98.4	98.7
20–24	98.2	98.4	98.2
25–29	98.8	98.8	98.2
30–34	98.6	98.4	97.9
35–39	98.2	96.6	98.1
40–44	98.5	94.7	95.8
45–49	97.7	86.7	93.3
50–54	91.4	76.4	83.6
55–59	92.6	76.8	81.7

Age Group (years)	Male	Female	Total
60–64	84.1	70.6	78.6
65–69	83.5	68.8	75.2
70–74	81.7	57.2	68.5
75 +	68.4	49.7	55.4
Total	**90.2**	**88.0**	**89.0**

Source: ZIMSTAT (2013) *Zimbabwe Population Census*

Table 10: Zimbabwean population aged 3–24 years currently attending school, by current level of education and sex, 2012

Current level	Male		Female		Total	
	Number	Percentage share	Number	Percentage share	Number	Percentage share
Pre School	225 051	10.9	223 643	11.1	448 744	11.0
Primary	1 275 976	61.8	1 245 150	61.8	2 521 126	61.8
Secondary	520 301	25.2	503 702	25.0	1 023 952	25.1
Tertiary	37 164	1.8	34 252	1.7	73 431	1.8
Missing	6 194	0.3	8 059	0.4	12 238	0.3
Total	**2 064 686**	**100.0**	**2 014 806**	**100.0**	**4 079 492**	**100.0**

Source: ZIMSTAT (2013) *Zimbabwe Population Census*

Table 11: Highest level of academic education completed among Zimbabweans aged 20 years and over, by age group and sex, 2012

Age Group	Secondary				Tertiary				Total population of cohort
	Male	Female	Total	Percentage share of total cohort	Male	Female	Total	Percentage share of total cohort	
20–24	303 686	357 713	661 399	56.15	24 946	27 845	52 791	4.48	1 177 950
25–29	289 348	313 250	602 598	54.04	52 462	51 284	103 746	9.30	1 115 034
30–34	245 206	226 394	471 600	52.12	52 501	43 796	96 297	10.64	904 831
35–39	188 826	155 963	344 789	47.82	47 653	34 799	82 452	11.44	721 019
40–44	138 818	98 450	237 268	46.81	43 803	27 204	71 007	14.01	506 911
45–49	68 979	46 281	115 260	36.05	29 731	19 197	48 928	15.30	319 725
50–54	33 262	25 226	58 488	19.98	18 050	12 403	30 453	10.40	292 718
55–59	20 437	15 991	36 428	15.57	11 394	7 336	18 730	8.01	233 912
60–64	13 156	11 498	24 654	13.98	6 732	4 851	11 583	6.57	176 363
65–69	8 530	8 019	16 549	13.13	4 628	3 521	8 149	6.47	126 039
70–74	6 114	5 983	12 097	12.73	3 384	2 418	5 802	6.10	95 039
75 +	8 110	8 665	16 775	12.98	3 913	2 959	6 872	5.32	129 195
Total	**1 324 472**	**1 273 433**	**2 597 905**	**44.80**	**299 197**	**237 613**	**536 810**	**9.26**	**5 798 736**

Source: ZIMSTAT (2013) *Zimbabwe Population Census*

Among 15–24-year-olds, enrolment increased from 91% in 2009 to slightly above 99% in 2011. This indicates a strong recovery from the decline during the years 2000–2008 (see Figure 4), when many children were not attending school on account of economic hardship. Moreover, variations in literacy across sub-groups of the population are low, with no significant difference between males and females (United Nations, 2012).

Zimbabwe still faces challenges with respect to primary school education. These challenges relate largely to budgetary constraints as a result of an inadequate inflow of government revenue. In 2012, Zimbabwe met the target recommended by UNESCO of allocating 6% of gross national product to education[13]. However, the majority of this expenditure goes on salaries (which still remain inadequate) and overheads, rather than on implementing policies that could improve the quality of education.

A closer look at the education system of Zimbabwe

The education system of Zimbabwe consists of seven years of primary schooling and six years of secondary schooling before students can enter university, college or other higher-education institutions.

The seven years of primary schooling culminate in four national Grade 7 examinations in: (i) mathematics, (ii) English, (iii) Shona or Ndebele, and (iv) contents, which refers to a combination of topics in the sciences and social sciences. The Grade 7 examination results determine for which secondary schools (or high schools) students qualify.

The secondary schools have two examination levels:

A) The ordinary level exams ('O' level), which are prepared and marked by the Zimbabwe Examinations Council and encompass:
   1. *Arts:* art, music;
   2. *Business and Commerce:* accounts, commerce, economics, computer studies;
   3. *Languages:* English, Shona, Ndebele, French, German, Latin, Portuguese, Chinese;
   4. *Liberal Arts:* English literature, religious education, geography, history;
   5. *Practical Subjects:* woodwork, metalwork, agriculture, technical drawing, fashion and fabrics, food and nutrition;
   6. *Sciences:* biology, chemistry, physics, physics with chemistry, integrated science, mathematics.

B) The advanced level ('A' level) examinations in Zimbabwe, which must be passed by any student wishing to apply to university. The 'A' level subjects offered in Zimbabwe encompass:
   1. *Arts:* Art, Music;
   2. *Business and Commerce:* Management of Business, Economics, Accounts, Computer Science, Statistics;
   3. *Languages:* English, Shona, Ndebele, French;
   4. *Liberal Arts:* English literature, Shona/Ndebele literature and language, geography, divinity, history, sociology;
   5. *Sciences:* biology, chemistry, physics, mathematics, advanced mathematics, computing science, technical graphics.

13 [7]CONFINTEA V Fifth International Conference on Adult Education, United Nations Educational, Scientific and Cultural Organization, July 1997.

Table 12 shows the recent evolution (2000–2012) in enrolment in science subjects at ordinary ('O') level and Figure 15 the pass rate in these subjects over the period 2003–2012. Chemistry and physics have a pass rate of between 70% and 80 %. However, the pass rate in mathematics is very low (16–19%). This indicator must be reversed, in order to guarantee a better performance in science and engineering education and promote the social appropriation of the results of research and innovation by society as a whole.

Table 12: Ordinary ('O') level science subject enrolment in Zimbabwe, 2000–2012

Year	Mathematics	Integrated science	Biology	Physical science	Physics	Chemistry
2000	101 595	155 822	22 694	13 454	1 098	1 173
2001	129 475	192 740	25 922	13 573	932	1 091
2002	105 277	156 443	26 710	13 805	1 774	1 466
2003	142 667	198 619	29 617	13 801	1 244	1 376
2004	102 987	161 862	26 329	12 280	1 120	1 183
2005	127 722	187 612	27 267	11 788	1 127	1 212
2006	110 014	168 740	23 783	10 968	1 000	1 218
2007	119 095	195 978	28 891	10 901	1 150	1 205
2008	n/a	n/a	n/a	n/a	n/a	n/a
2009	50 301	71 412	14 016	5 825	889	802
2010	80 596	119 540	16 903	6 543	1 152	934
2011	88 146	130 520	18 284	8 096	1 146	1 443
2012	101 971	135 630	18 342	8 138	2 233	2 133

Source: Ministry of Primary and Secondary Education (2013)

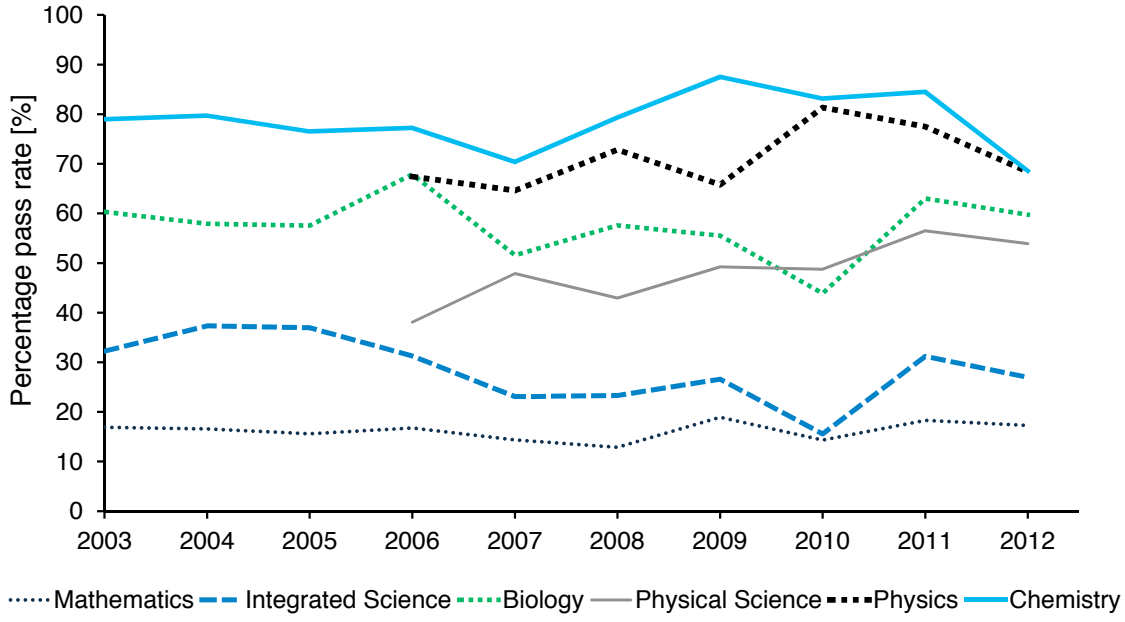


Figure 15: Ordinary ('O') level science subject pass rate in Zimbabwe, 2003–2012. Source: Ministry of Primary and Secondary Education (2013)

Table 13 shows the recent evolution (2002–2012) in enrolment among science subjects at the advanced ('A') level and Table 14 the pass rate in these subjects. In recent years (2009–2012), the pass rate has reflected relatively good scores in most subjects. The mathematics pass rate showed continual improvement over this period but it was in computer sciences that the progression was most spectacular (65.74% pass rate in 2009, compared to 93.56% in 2012). It should be of some concern that just 5.7% of the students enrolled in mathematics at ordinary level went on to study the same subject at advanced level.

Post-secondary education includes diploma-level training at colleges and polytechnics, as well as the obtention of degrees at university level. The transition from lower to higher educational levels is determined by the performance of each student in national examinations at the end of a particular cycle. This is particularly so for public colleges and universities. They are highly competitive owing to the small number of programmes they offer.

The arrival of private colleges and universities has brought more opportunities to the many deserving students who failed to make it into Zimbabwe's highly competitive public universities and colleges. The Ministry of Higher and Tertiary Education, Science and Technology Development and the Zimbabwe are responsible for accrediting and recognizing both public and private institutions.

According to the *Medium Term Plan (2011–2015)* [Republic of Zimbabwe, 2011], the main challenges and constraints facing the education sector are the following: (i) inadequate funding; (ii) inadequate learning and teaching materials; (iii) the flight of skills, owing to poor remuneration; (iv) deteriorating educational infrastructure and equipment at institutions, including teachers' accommodation; (v) prohibitive distances to cover, especially in newly resettled areas; (vi) high cost of education, including examination fees; and (vii) the HIV and AIDS pandemic.

The *Medium Term Plan* established the following policy objectives: (i) provide universal primary education, including early childhood development; (ii) restore quality education; (iii) enhance the credibility of the local examination management system; (iv) retain and attract skilled human resources; (v) promote gender parity at secondary and tertiary levels; (vi) rehabilitate existing schools; and (vii) promote teaching of science, mathematics and technical and vocational education.

Table 13: Advanced ('A') level science subject enrolment in Zimbabwe, 2002–2012

Year	Mathematics	Physics	Chemistry	Biology	Advanced Mathematics	Computer science
2002	7 798	1 823	2 823	1 945	n/a	n/a
2003	8 867	1 897	3 055	1 946	n/a	n/a
2004	9 643	1 891	2 971	1 899	n/a	n/a
2005	9 133	1 610	2 909	2 093	n/a	n/a
2006	n/a	1 479	2 898	2 254	n/a	n/a
2007	n/a	n/a	n/a	n/a	n/a	n/a
2008	n/a	n/a	n/a	n/a	n/a	n/a
2009	5 318	1 254	2 030	1 446	41	193
2010	5 510	1 272	2 236	1 780	20	139
2011	5 226	1 266	2 286	1 657	61	140
2012	5 827	1 297	2 565	1 795	191	225

Source: Ministry of Primary and Secondary Education (2013)

Table 14: Advanced ('A') level pass rates (%) in science subjects in Zimbabwe, 2003–2012

Year	Mathematics	Physics	Chemistry	Biology	Advanced mathematics	Computers
2003	57.05	76.40	n/a	74.10	n/a	n/a
2004	n/a	n/a	n/a	n/a	n/a	n/a
2005	64.30	87.55	n/a	79.10	n/a	n/a
2006	64.15	83.35	n/a	88.05	n/a	n/a
2007	n/a	n/a	n/a	n/a	n/a	n/a
2008	n/a	n/a	n/a	n/a	n/a	n/a
2009	74.74	70.96	71.90	78.15	92.50	65.74
2010	74.30	82.10	73.50	80.30	95.80	68.50
2011	80.97	83.90	85.73	91.79	96.72	91.42
2012	84.91	83.61	79.61	66.57	86.05	93.56

Source: Ministry of Primary and Secondary Education (2013)

The policy targets defined by the *Medium Term Plan* are the following: (i) reduce pupil–teacher ratio at primary school level to 28:1 by 2015; (ii) reduce pupil–textbook ratio at primary school level to 1:1 by 2015; (iii) allocate 30% of the total budget to the education sector by 2015; (iv) achieve gender parity at secondary and tertiary levels by 2015; and (v) increase the adult literacy rate from 88.4% to 98% by 2015.

In order to reach these objectives and targets, the *Medium Term Plan* proposed the following policy measures: (i) increase and maintain consistent funding for the education sector; (ii) introduce free and compulsory primary education; (iii) promote access to secondary education for every child; (iv) promote compulsory education for children, especially girls, up to secondary level; (v) no child, especially girls, should fail to go to school for lack of the means to pay the fees; (vi) incorporate gender, the Constitution and human rights, hygiene and life skills, as well as livelihood skills, in the education curriculum at all levels; (vii) provide adequate teaching and learning materials; (viii) expand vocational and professional education to youth, including the mainstreaming and teaching of practical subjects in secondary schools; (ix) establish a Women's Education Fund to ensure no girl drops out for lack of school fees; (x) support people with disabilities by providing free education at all levels; (xi) Increase the involvement of parents in running schools through appropriate legislative reforms; (xii) restructure and commercialize the Zimbabwe School Examinations Council; (xiii) Integrate environmental best practices and community engagement for the development of sustainable schools; and (xiv) computerize all schools to lay the foundations for an e-economy and the orientation of the education sector towards the sciences.

The current policy on higher and tertiary education is premised on the enhancement of quality education with a focus on achieving the Millennium Development Goals and implementing the priorities of the African Union's *Plan of Action* for the Second Decade of Education for Africa (2006–2015) and the provisions of the *SADC Protocol on Education and Training* (Republic of Zimbabwe, 2011; United Nations, 2012; see also page 49).

The Ministry of Higher and Tertiary Education, Science and Technology Development is trying to ensure the delivery of a highly skilled labour force that will significantly enhance the country's competitiveness. The ministry's mandate is to rebuild a high-quality higher education system adapted to the current and projected needs of the economy. It also aims to be the leading provider of quality and relevant education internationally by 2020 and to guarantee that Zimbabwe becomes a regional leader in the creative use of new and existing knowledge, skills, attitudes, and resources through the local mobilization and provision of quality higher and tertiary education (Republic of Zimbabwe, 2011).

Over the period of the *Medium Term Plan (2011–2015*), higher and tertiary education will focus on the strategic objectives articulated in the current *Strategic Plan (2009–2014)* in three areas, namely teacher education; technical and vocational education; and training and university education.

According to the *Medium Term Plan*, the higher and tertiary education sector has encountered a number of challenges which include the following: (i) brain drain has resulted in a large gap in professional skills that has impacted negatively on service delivery and the full utilization of institutional capacities; (ii) the inadequate provision of incentives schemes for the recruitment and retention of qualified and experienced staff at tertiary institutions; (iii) concern over the social well-being and career progression of the growing numbers of students studying abroad (6 000 in South Africa, 220 in Algeria); (iv) failure to attract back the skilled and qualified professionals in the Diaspora so that they can contribute to the country's development; (v) a lack of adequate financial assistance for students unable to pay tuition fees; (vi) lack of an enabling regulatory framework for forging public–private partnerships in higher and tertiary education institutions; and (vii) inadequate funding for the refurbishment of infrastructure and completion of projects.

The *Medium Term Plan* has the following higher and tertiary policy objectives: (i) provide attractive incentive schemes for the retention and recruitment of highly qualified professionals; (ii) intensify the democratization of higher and tertiary education and training for all, through conventional and open and distance learning strategies; (iii) attract back skilled and qualified Zimbabwe nationals in the diaspora through the human capital website to contribute to the country's development; (iv) provide an enabling regulatory framework for the operations of public–private partnerships in higher and tertiary education Institutions; and (v) enhance the resource base and management of higher and tertiary education. The *Medium Term Plan* also determines the following policy targets: (i) establish and operationalize the Zimbabwe Examinations and Qualifications Authority); (ii) develop a comprehensive legal and institutional framework for higher education; (iii) refurbish infrastructure and complete unfinished projects; and (iv) appoint two education attachés to South Africa and Algeria.

The policy measures proposed for the higher and tertiary sector are the following: (i) implement attractive retention packages for staff at higher and tertiary institutions; (ii) monitor the social well-being and career progression of students studying outside the country; (iii) provide adequate financial assistance to students with no capacity to pay tuition fees at universities, polytechnics and teachers colleges, through the cadetship scheme; (iv) provide funds to refurbish infrastructure and complete ongoing projects; (v) appoint education attachés to attend to the welfare of the growing number of students studying in South Africa and Algeria; (vi) extend the use of new technologies to universities, polytechnics and teachers colleges; (vii) provide adequate funds for the cadetship scheme; (viii) formulate a regulatory framework for public–private partnerships in higher and tertiary education institutions; (ix) intensify income-generating projects and forge public–private partnerships; and (x) market and formalize the human capital website[14].

Table 15 shows enrolment in higher and tertiary education in Zimbabwe between 2006 and 2012. The hyperinflation and economic crisis of 2008 generated a drop of 18.7% in total tertiary enrolment in 2009. In recent years, this trend has reversed, with enrolment being 11.8% higher in 2012 than in 2006.

14 The Zimbabwean human capital website provides a platform for skilled Zimbabweans to register and create profiles that can help potential employers/businesses/organizations find them (see Box 12). The initiative allows professionals in the diaspora to contribute to the country's socio-economic development. It also provides information on investment opportunities for new and existing businesses: www.zimbabwehumancapital.org/

Table 15: Enrolment in higher and tertiary education in Zimbabwe, 2006–2012

	2006	2007	2008	2009	2010	2011	2012
Africa University	1 155	1 560	1 391	666	1 566	1 384	1 701
Agricultural colleges	1 622	2 144	1 245	1 717	927	816	958
Bindura University of S&T	1 056	1 654	2 116	1 923	2 116	4 394	4 732
Catholic University	313	313	332	315	385	387	437
Chinhoyi University of Technology	2 286	3 287	2 586	2 381	4 533	4 533	5 124
Great Zimbabwe University	2 394	2 655	3 036	2 690	2 671	4 201	4 481
Harare Institute of Technology*	–	141	343	273	622	1 245	1 446
Lupane State University*	–	–	78	205	521	862	1 206
Midlands State University	9 904	10 422	10 887	3 868	10 648	10 258	14 915
National University of Science and Technology	3 594	3 594	5 651	5 099	4 057	7 098	3 087
Solusi University	1 877	1 875	1 753	1 233	1 952	338	672
Teachers Training Colleges	18 297	17 665	15 593	10 812	11 757	12 825	18 809
Technical colleges	14 361	13 040	12 855	11 234	12 220	16 859	17 432
University of Zimbabwe	12 050	11 484	11 725	12 271	7 636	8 310	11 975
Vocational training colleges	988	915	728	765	1 016	2 295	1 807
Women's University in Africa	473	613	1 581	1 203	1 537	1 517	1 472
Zimbabwe Open University	18 307	17 246	17 816	16 286	15 303	8 568	8 895
Total	**88 677**	**88 608**	**89 716**	**72 941**	**79 467**	**85 890**	**99 149**

*The Harare Institute of Technology had its first intake of students in 2007 and Lupane State University in 2008.

Source: ZIMSTAT (2013)

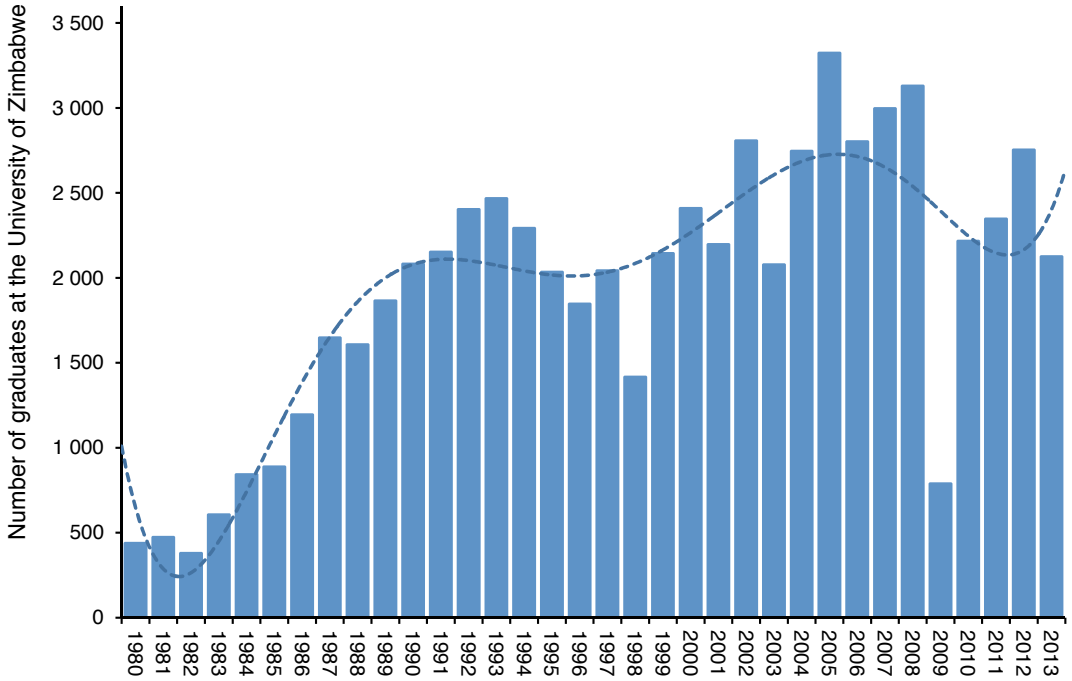


Figure 16: Total number of graduates from the University of Zimbabwe, 1980–2013. Source: UNESCO, based on data provided by the University of Zimbabwe

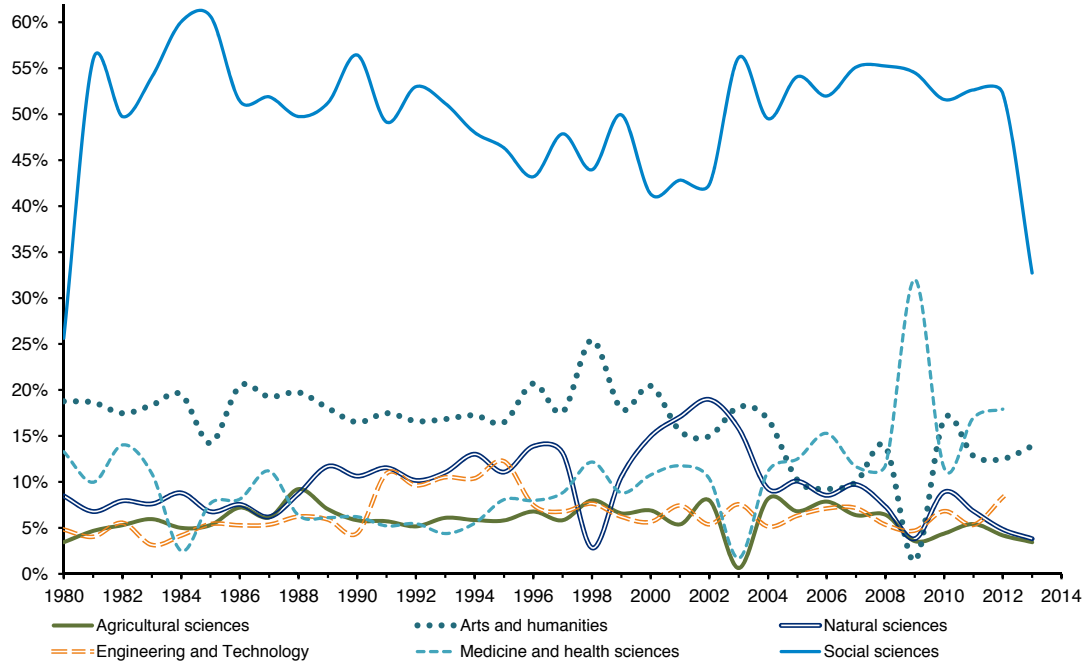


Figure 17: Percentage distribution of graduates from the University of Zimbabwe, by field of science, 1980–2013. Source: UNESCO.

Table 16 presents the number of graduates from the University of Zimbabwe (1980–2013). This university is the oldest in the country. Although it represents only around 13% of total tertiary enrolment in Zimbabwe, the university accounts for more than 58.9% of all Zimbabwean scientific articles listed by the Web of Science (see Table 27) during the post-independence era. Between 1980 and 2012, science graduates made up 10.6% of all graduates, compared to just 6.9% for engineers.

In 2009, the number of graduates from the University of Zimbabwe fell by 75% in comparison with the preceding year, as shown in Figure 16. It is evident that the 2008–2009 economic crisis affected the number of graduates at the University of Zimbabwe, as it did in the rest of the country's higher education system.

Figure 17 represents the long-term evolution of graduates by field of science. These fields correspond to the categories defined by the *Recommendation Concerning the International Standardization of Statistics on Science and Technology*, proposed by UNESCO member states at the Organization's General Conference (UNESCO, 1978) and by the *Frascati Manual* (OECD, 2002). Figure 17 reveals that more than half of graduates study social sciences. This is due to the fact that the graduates of commerce, education and law are included in the social sciences category. It is important to note that the share of 'hard science' graduates progressed between 1980 and 2002[15] (reaching almost 19%) before falling away to less than 5% by 2012. Over these two decades, the share of engineering graduates remained mostly below 6%, with the exception of the period between 1991 and 1995 when their share almost doubled.

The foregoing analysis is only a proxy, since it covers a single university. The lack of a complete set of statistics on trends in enrolment and graduation by field for the country's entire university system precludes any comprehensive analysis of the situation in Zimbabwe.

Table 17 presents the number of masters and medical doctors/PhDs obtained from the University of Zimbabwe in 2012. In this particular case, MScs only represent 2.7% of the total, engineering 6.5%, agriculture 3.7% and health sciences 9.9%. There are no PhDs in science, compared to two PhDs (11% of the total) in each of agriculture and social sciences, and four medical doctors (22.5% of this small sample).

15 With one exception during the year 1998

Table 16: Number of graduates from the University of Zimbabwe, by faculty, 1980–2013

	Agriculture	Arts	Commerce	Education	Engineering	Law	Science	Social Studies	Health science	Veterinary Science	UZ School of Technology	Total
1980	15	82	30	40	21	42	37	112	58			437
1981	22	88	76	30	19	40	32	118	47			472
1982	20	66	48	10	21	34	30	96	53			378
1983	36	111	123	16	19	60	46	128	66			605
1984	42	164	156	74	35	95	74	180	21			841
1985	47	126	182	34	48	112	60	210	68			887
1986	75	244	267	48	63	86	90	213	97	11		1194
1987	77	317	251	310	88	76	102	217	184	24		1646
1988	115	317	251	183	100	84	140	281	102	33		1606
1989	118	336	309	150	110	100	218	396	114	13		1864
1990	106	343	326	215	92	225	221	408	129	15		2080
1991	109	376	309	156	235	71	248	521	112	14		2151
1992	100	399	382	204	231	104	244	583	131	24		2402
1993	116	415	330	279	259	72	272	581	108	34		2466
1994	110	395	392	144	238	77	298	487	126	24		2291
1995	101	335	162	276	249	56	225	448	164	17		2033
1996	93	382	191	178	138	68	256	360	147	32		1845
1997	100	359	173	388	138	55	268	361	180	19		2041
1998	88	360	205	69	108	47	40	301	172	25		1415
1999	118	384	207	427	133	40	226	396	189	23		2143
2000	130	492	293	157	136	52	360	493	259	36		2408
2001	98	341	248	185	163	70	375	437	258	20		2195
2002	195	420	284	254	151	83	532	568	290	29		2806
2003	10	377	244	300	157	75	328	547	35	3		2076
2004	203	461	328	387	141	108	254	536	306	21		2745
2005	193	339	453	405	210	181	335	758	415	33		3322
2006	187	259	350	241	199	141	239	724	428	33		2801
2007	172	299	437	243	214	91	291	880	349	19		2995
2008	160	433	393	400	167	303	229	632	370	41		3128
2009	27	11	312	44	37	1	30	72	252	1		787
2010	89	372	336	68	151	158	197	581	255	8		2215
2011	101	301	526	95	125	115	160	499	398	26		2346
2012	94	344	568	134	126	152	133	584	493	21	103	2752
2013	123	504	576	138	85	105	99	706	414	41	64	2855

Note: The Faculty of Veterinary Science opened in 1985 and the School of Technology in 2012.

Source: University of Zimbabwe (2014)

PhD-level scientists are the best source of new ideas for turning R&D into innovative products and processes, including as concerns medical challenges (Chetsanga *et al.*, 2009). Despite the fact that human resources are a pillar of any research and innovation policy, the *Medium Term Plan* does not discuss any explicit policy for promoting postgraduate studies in science and engineering. The scarcity of new PhDs in science and engineering fields from the University of Zimbabwe is symptomatic of this omission.

Table 17: Number of master's degrees and medical doctors/PhDs from the University of Zimbabwe, 2012

	Masters			MD/PhD		
	Male	Female	Total	Male	Female	Total
Agriculture	14	7	21	1	1	2
Arts	18	14	32	8	1	9
College of Health Sciences	34	22	56	4	0	4
Commerce	160	81	241	1	0	1
Education	37	11	48	0	0	0
Engineering	24	13	37	0	0	0
Law	5	24	29	0	0	0
Natural sciences	13	2	15	0	0	0
Social studies	53	33	86	0	2	2
Veterinary Sciences	1	0	1	0	0	0

Source: University of Zimbabwe (2014)

Table 18 shows university graduates from Zimbabwe by field of science in 2013. The aggregation follows the same criteria used in Figure 17.

Table 18: Graduates from different Zimbabwean universities, by field of science, 2013

Number of university graduates in Zimbabwe in 2013								
Name of the university	Field of science						Total graduates by university	Percentage of national graduates by university
	Agricultural Sciences	Arts & Humanities	Engineering & Technology	Medicine & Health Sciences	Natural Sciences	Social Sciences		
Africa University	21	97	0	22	0	179	319	2.68
Bindura University of Science and Technology	86	0	0	0	102	425	613	5.16
Catholic University	0	59	0	0	0	57	116	0.98
Chinhoyi University of Technology	0	90	75	0	0	685	850	7.15
Great Zimbabwe University	0	570	0	0	5	599	1174	9.87
Harare Institute of Technology	0	0	154	0	0	43	197	1.66
Lupane State University	18	14	0	0	0	160	192	1.61
Midlands State University	159	1103	0	0	376	1479	3117	26.21
National University of Science and Technology	0	0	709	0	308	597	1614	13.57
University of Zimbabwe	123	614	76	328	76	907	2124	17.86
Women's University in Africa	21	0	38	0	0	372	431	3.62
Zimbabwe Open University	73	295	0	0	81	695	1144	9.62
Total graduates by field of science	**501**	**2842**	**1052**	**350**	**948**	**6198**	**11891**	**100.00**
Percentage by field of science	4.21	23.90	8.85	2.94	7.97	52.12	100.00	

Source: UNESCO and Ministry of Higher and Tertiary Education, Science and Technology Development (2014)

Student mobility

According to the UNESCO Institute for Statistics (2012), 'SADC students are among the most mobile in the world, with six out of every 100 tertiary students studying abroad'. In 2009, 89 000 SADC students studied outside their home country, representing 5.8% of tertiary enrolment in the region. This ratio is higher than the regional average for sub-Saharan Africa (4.9%) and three times the world average (2.0%).

One explanation for the high mobility of SADC students can be found in the SADC *Protocol on Education and Training* (1997), which sets out to facilitate mobility. Zimbabwe is one of only three signatory countries (the others being South Africa and Swaziland) which have respected the agreement in the protocol that countries cease charging higher fees for SADC students than for national students, a practice considered a potential barrier to student mobility (UNESCO Institute for Statistics, 2012).

Zimbabwe is one of several SADC countries which have a relatively smaller dispersion of students than their neighbours, the others being Botswana, Lesotho, Madagascar, Namibia and Swaziland. Students from these countries tend to be fairly concentrated in one main destination: South Africa[16]. South Africa hosted about 61 000 international students in 2009, two-thirds of whom came from other SADC nations. South Africa is not only the leading host country in Africa but also ranks 11th among host countries worldwide. Its higher education sector is well-developed with strong infrastructure and several respected research institutions that appeal to international students. By attracting so many African students, South Africa is making an important contribution to the continent's human resource development and helping to retain skilled graduates in Africa (UNESCO Institute for Statistics, 2012).

The number of Zimbabwean students choosing to study abroad more than tripled between 1999 and 2012, to 27 994 (see Figure 18 and Table 19). Between 2006 and 2012, the number of students enrolled in tertiary and higher education in Zimbabwe rose far more slowly (up by 11%, see Table 15) than the number studying abroad (up by 178%). Interestingly, the share of students studying abroad dropped slightly in 2012, after peaking the previous year.

South Africa is by far the preferred destination. It attracted two-thirds of all Zimbabwean students living abroad in 1999 and as many as 83% in 2011. Although the United Kingdom remains the second country of choice, the number of Zimbabwean students opting for this European destination has stagnated: 1 364 in 1999 (17% of all Zimbabwean students living abroad), compared to 1 039 (less than 4%) in 2012. Outside Africa, Western Europe and North America still attract the bulk of Zimbabwean students but Australia is also a popular destination (Table 19).

There were 889 foreign stuents attending Zimbabwean universities in 2009 but this number had dropped to 352 by 2012 (data are unavailable for earlier years).

16 With the exception of students from Madagascar, who prefer France

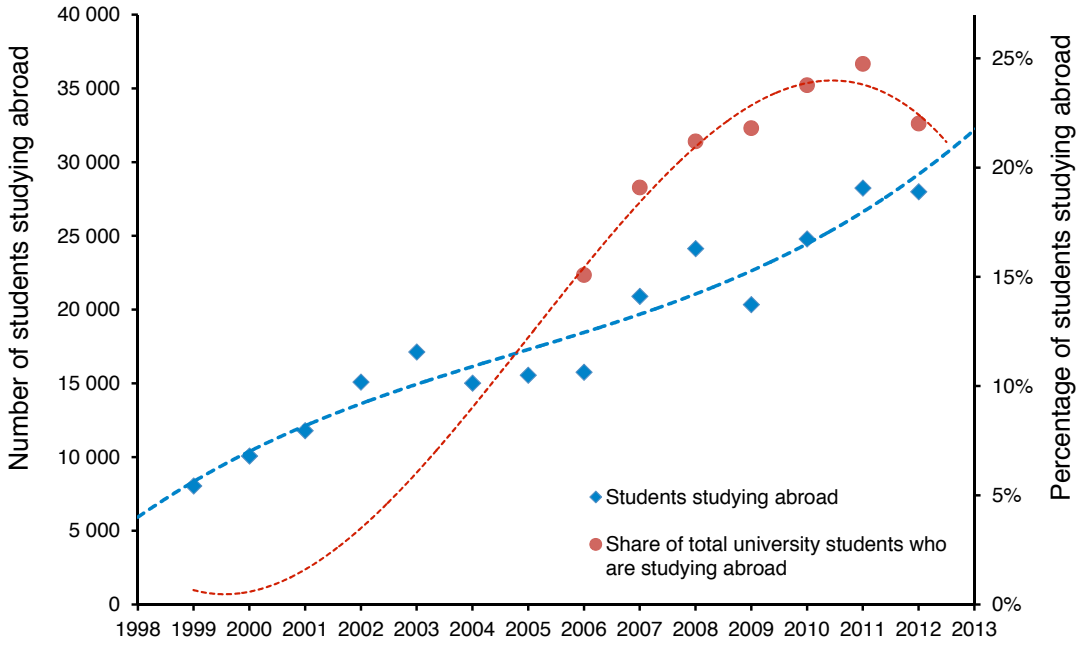


Figure 18: University students from Zimbabwe studying abroad, 1999–2012. The scale for the blue dots can be found on the vertical axis on the left, that for the red triangles on the right axis. The dotted lines are the best-fitting curves. Source: UNESCO Institute for Statistics

Table 19: Destination of Zimbabwean university students studying abroad, 1999–2012

Year	Zimbabwean students studying abroad	Central and Eastern Europe	East Asia and the Pacific	South and West Asia	Latin American and the Caribbean	North America and Western Europe	South Africa	United Kingdom	Australia
1999	8 043	31	11	4	n/a	2 399	5 324	1 364	n/a
2000	10 072	25	245	4	11	3 148	6 489	1 891	227
2001	11 790	24	n/a	6	8	4 943	7 017	2314	n/a
2002	15 083	18	n/a	10	16	5 327	9 099	2,678	804
2003	17 133	18	n/a	10	25	5 016	10 586	2 850	968
2004	15 021	20	n/a	9	20	4 738	8 824	2 741	892
2005	15 551	27	n/a	6	45	4 786	9 507	2 658	983
2006	15 755	28	n/a	9	n/a	4 434	9 652	2 655	1 075
2007	20 902	23	n/a	13	n/a	3 870	14 690	2 475	1 361
2008	24 136	89	n/a	17	n/a	3 445	17 766	2 027	1 464
2009	20 346	101	n/a	21	104	3 093	14 359	1 740	1 373
2010	24 790	90	n/a	25	101	2 872	19 294	1 413	1 132
2011	28 249	88	n/a	29	49	2 872	23 373	1 201	891
2012	27 994	80	n/a	29	n/a	n/a	n/a	1 039	657

Source: UNESCO Institute for Statistics (2014)

R&D indicators for Zimbabwe

In 2003, African countries endorsed the compilation of indicators for scientific research, technological development and innovation. To make this possible, the African Science, Technology and Innovation Indicators (ASTII) initiative was launched on 17 September 2007 in Mozambique as a flagship programme of *Africa's Science and Technology Consolidated Plan of Action* (CPA). The overall goal of ASTII is to help improve the quality of STI policies at national, regional and continental levels by strengthening Africa's capacity to develop and use STI indicators. ASTII aims to support evidence-based policy addressing Africa's development challenges in the context of STI. So far, ASTII has brought together 28 African Union member states.

In 2012, the Government of Zimbabwe conducted a *National Survey of Research and Development* (Republic of Zimbabwe, 2013d). This pilot survey entailed the collection of R&D data for two sectors: higher education and government. The business enterprise sector and private non-profit sector are conspicuous by their absence from the survey coverage. The period covered by the survey was 1 January to 31 December 2012. The data obtained were used to measure the performance of national R&D against the targets set by the government and for international comparisons.

The government sector includes state-funded research centres such as Matopo Research Station, the Scientific and Industrial Research and Development Centre and Lowveld Research Station. The higher education sector encompasses all universities and polytechnic colleges in the country (see Table 15).

Table 20 shows the breakdown by performance sector of R&D personnel in Zimbabwe[17] (for a definition, see the glossary on page 199).

Table 20: R&D personnel in Zimbabwe by performance sector, 2012

Sector	Researchers (HC)			Technicians (HC)			Support staff (HC)		
	Female	Male	Total	Female	Male	Total	Female	Male	Total
Business enterprise	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Government	77	151	228	50	79	129	132	138	270
Higher education	615	1896	2511	90	211	301	80	178	258
Private non-profit	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Total	**692**	**2047**	**2739**	**140**	**290**	**430**	**212**	**316**	**528**

Sector	Researchers (FTE)			Technicians (FTE)			Support staff (FTE)		
	Female	Male	Total	Female	Male	Total	Female	Male	Total
Business enterprise	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Government	37	72	109	15	27	41	62	86	148
Higher education	295	910	1205	26	72	98	38	110	148
Private non-profit	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Total	**332**	**983**	**1315**	**41**	**99**	**139**	**100**	**196**	**296**

HC = head count
FTE = full-time equivalent

Source: Republic of Zimbabwe (2013d) *National Survey of Research and Development*

17 The editors of the present GO→SPIN country profile found what appear to be typing mistakes in the analysis of the findings of the original government survey. Table 20 was reviewed assuming that, within the survey, the head count values were correct, as well as the numbers provided for estimating the share of his/her time that each individual researcher, technician and support staff devoted to R&D on average each year.

R&D PERSONNEL IN ZIMBABWE

According to Table 20, R&D personnel in the public sector currently total 3 697 by head count (HC) and 1 749 in full-time equivalent (FTE). These numbers break down into 2 739 (HC) researchers, 430 (HC) technicians and 528 (HC) support staff. The full-time equivalent numbers[18] are the following: 1,315 researchers, 139 technicians and 296 support staff.

Of total R&D personnel in the public sector (HC), 28.2 % are women. They represent 25.3% of researchers, 32.6% of technicians and 40.2% of support staff. If we consider the full-time equivalent for female personnel, the figures are the following: 27% of all personnel (FTE) are women: 25.2% of researchers, 29.5% of technicians and 33.8% of support staff.

According to the national census in 2012, Zimbabwe counts a total population of 13 061 299. This implies that the number of R&D personnel (public sector only) per million population amounts to 283 (HC) and 134 (FTE) respectively. If we break this down by category, the total number of public-sector researchers per million population amounts to 210 (HC) and 101 (FTE), the number of technicians 33 (HC) and 11 (FTE). Lastly, the number of support staff per million population comes to 40 (HC) and 23 (FTE).

If we compare these findings with the survey conducted by UNESCO half a century earlier (see Box 7), we find that the head count for researchers per million population has increased by 288% over 50 years, or at a rate of 5.65% per year, whereas the number of technicians has fallen by 71% at a rate of -1.39% per year. In 1962, there were 72.9 researchers (HC) per million population. When researchers were combined with technicians, the figure climbed to 113.8 (HC) per million population

Table 21 shows researchers by field of science. Of Zimbabwe's 2 739 researchers, 30% work in the natural and exact sciences, 13% in engineering and technology, 14% in agricultural sciences, 22% in social sciences and 15% in humanities. There is a logical explanation for the paltry number of researchers in medical and life sciences (less than 1% of the total, according to the 2012 survey). Most of the personnel working in medical and health research are at the University of Zimbabwe's School of Medicine, which did not respond to the survey. The number of researchers working in this field should be much bigger, since, in the past decade, medical and health research represented 31–45% of Zimbabwe's scientific publications (see Figure 27). In addition to the University of Zimbabwe's School of Medicine, the following contribute to medical and health research: National Institute of Health Research, Biomedical Research and Training Institute, Ministry of Health and Harare City Health Department (see Table 27).

Table 21: Researchers in Zimbabwe's public sector by field of science, 2012

Researchers	Female (HC)	Male (HC)	Total (HC)	Female (FTE)	Male (FTE)	Total (FTE)
Agricultural sciences	97	284	381	47	136	183
Arts and humanities	118	306	424	57	147	204
Engineering and technology	85	280	365	41	134	175
Natural and exact sciences	208	615	823	100	295	395
Medical and health sciences	2	3	5	1	1	2
Social sciences	146	461	607	70	221	291
Other	36	98	134	17	47	64
Total	**692**	**2 047**	**2 739**	**332**	**983**	**1 315**

HC = head count
FTE = full-time equivalent

Source: Republic of Zimbabwe (2013d) *National Survey of Research and Development*

18 The decimals for the FTE figures have been rounded off to the closest integer.

The distribution of R&D personnel (HC) and researchers (HC) by level of qualification (using the International Standard Classification of Education) is presented in the Table 23. According to the data provided, only 13.2% of R&D personnel hold a PhD or equivalent degree, 58.8% a master's or bachelor's degree, 9.4 % a tertiary diploma and 18.6% a post-secondary, non-tertiary diploma. Among researchers specifically, 17.5% hold a PhD or equivalent degree, 75.9% a master's or bachelor's, 3.8 % a tertiary diploma and 2.8% a post-secondary, non-tertiary diploma.

Table 22: R&D personnel in Zimbabwe's public sector by level of qualification, 2012

Qualification	R&D Personnel			Researchers						
				Higher education sector		Government sector		Total		
	Female	Male	Total	Female	Male	Female	Male	Female	Male	Total
ISCED 6	131	358	489	124	346	3	7	127	353	480
ISCED 5 A	546	1619	2175	457	1435	68	118	525	1553	2078
ISCED 5 B	116	230	346	22	71	2	9	24	80	104
ISCED 4 or below	251	436	687	12	44	4	17	16	61	77
Total	**1 044**	**2643**	**3697**	**615**	**1896**	**77**	**151**	**692**	**2047**	**2739**

ISCED = International Standard Classification of Education, see Annex 1

Source: Republic of Zimbabwe (2013d) *National Survey of Research and Development*

R&D EXPENDITURE IN ZIMBABWE

Chetsanga *et al.* (2009) estimated that gross expenditure on research and development (GERD) in Zimbabwe was equivalent to 0.12% GDP in 2009. However, the authors of Zimbabwe's *National Survey of Research and Development* (Republic of Zimbabwe, 2013d) estimated GERD at US$76.3 million just three years later. The Ministry of Finance and Economic Development having estimated GDP at US$10 068 million for the same year, GERD should thus have represented 0.76% of GDP in 2012.

The *National Survey of Research and Development* also provided a rough estimate of the share of GERD provided by the government sector (48%), higher and tertiary education sector (46%), foreign sources (3%), private non-profit organizations (2%) and business enterprise sector (1%).

BOX 7 – UNESCO'S FIRST SURVEY OF R&D IN ZIMBABWE IN 1962

On 14 November 1958, the General Assembly of the United Nations (13th session, 780th plenary meeting) adopted Resolution 1260 requesting the Secretary-General:

> *… in co-operation with the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the other Specialized Agencies concerned with the peaceful application of science, as well as the International Atomic Energy Agency, to arrange for a survey to be made on the main trends of inquiry in the field of the natural sciences and the dissemination and application for peaceful ends of such scientific knowledge, and on the steps which might be taken by the United Nations, the Specialized Agencies and the International Atomic Energy Agency towards encouraging the concentration of such efforts upon the most urgent problems, having regard to the needs of the various countries…*

In the same resolution, the General Assembly requested that the Secretary-General 'submit this survey to the Economic and Social Council at its thirtieth session' in July 1960.

Ultimately, this report was co-ordinated and edited by Pierre Auger, a prominent physicist and former Assistant Director-General for Science at UNESCO. The study included a description of the most influential trends in scientific research and a series of analyses of their potential long-term impact on humanity (Auger, 1961). The report introduced the need for states to establish national scientific and technological policies, as well as new schemes fostering international scientific cooperation, one example being UNESCO's proposal in the early 1950s for the creation of the European Centre for Nuclear Research, CERN).

Auger's report broke new ground. For the first time, the UN system proposed a standard classification for scientific research and experimental development and defined scientific researchers, technicians and engineers. This preceded the OECD's *Frascati Manual* (1963) and even the OECD itself, founded in 1961.

Using the standard classification proposed by Auger, UNESCO conducted a regional survey in 1962 and 1963 of the scientific and technical potential of 42 African countries[19]. This survey provided numerical data for the first time on the scientific and technical personnel working in different scientific disciplines and special fields of scientific investigation, as well as an inventory of research institutions and the number of researchers and technicians, the size of laboratories and experimental stations, amount of library volumes, etc. The results were presented to an International Conference on the Organization of Research and Training in Africa in Relation to the Study, Conservation and Utilization of Natural Resources, jointly organized by UNESCO and UNECA in Lagos (Nigeria) between 28 July and 6 August 1964.

Table 23 overleaf presents the main findings of UNESCO's survey of R&D in Zimbabwe in 1962, when the country was still known as South Rhodesia. In those days, Zimbabwe had at least 113.8 researchers and technicians (HC) per million population, 72.9 of which were researchers.

19 UNESCO/CORPSA/4.B; Paris, 6 July 1964

Table 23: Main findings of UNESCO survey of R&D in Zimbabwe, 1962

	Institution		Total personnel [HC]	Researchers [HC]	Technicians [HC]	Laboratories [m2]	Area [ha]
1	Agricultural Research Council of Central Africa	Inter-state research institution established by agreement by the Governments of Malawi, Southern Rhodesia and Zambia	103	30	15	1533	n/a
2	Federal Malaria Eradication Organization		n/a	n/a	n/a	n/a	n/a
3	Lake Kariba Fisheries Research Institute		n/a	n/a	n/a	n/a	n/a
4	Ministry of Agriculture and Natural Resources	Department of Research and Specialist Services	671	44	33	n/a	18 951
5		Grasslands Research Station	164	8	18	46	243
6		Henderson Research Station	227	14	12	n/a	1 821
7		Fisheries Research Centre	23	2	1	n/a	20
8		Matopos Research Station	450	11	36	79	9 712
9		Rhodes Inyanda Orchards Horticulture Experiment Station	37	2	1	37	243
10		Sabi valley Experiment Station	131	3	4	279	49
11		Branch of Tsese and Trypanosomiasis Control	38	13	n/a	56	n/a
12		Veterinary Research Laboratory	n/a	3	n/a	n/a	n/a
13	Ministry of Health	Bilharziasis Research Laboratory	23	3	9	n/a	n/a
14	Ministry of Internal Affairs	National Museums Administration	2	1	n/a	n/a	n/a
15	Ministry of Mines and Lands	Department of National Parks and Wild Life Management	30	4	4	n/a	n/a
16		Forestry Commission Research Branch	n/a	7	n/a	n/a	n/a
17		Geological Survey	32	16	n/a	201	n/a
18	Ministry of Transport and Works	Meteorological Department	158	2	n/a	n/a	n/a
19	Ministry of Water Development	Hydrological Branch	37	5	n/a	34	n/a
20	National Museum		14	5	n/a	n/a	n/a
21	Pasteur Institute and Public Health Laboratory		n/a	5	n/a	n/a	n/a
22	Queen Victoria Museum		11	4	n/a	n/a	n/a
23	Salisbury Polytechnic	Government Institute affiliated with Ministry of Education	62	30	n/a	n/a	n/a
24	Tobacco Research Board		n/a	16	n/a	n/a	n/a
25	Umtali Museum		4	2	n/a	n/a	n/a
26	University College of Rhodesia	Faculty of Science	10	3	5	929	81
27		Department of Botany	34	13	7	325	n/a
28		Department of Chemistry	30	22	5	4 459	n/a
29		Department of Geology	9	5	4	n/a	n/a
30		Department of Physics	18	2	10	2 323	n/a
31		Department of Zoology	40	17	n/a	2 787	n/a
	Total		**2 358**	**292**	**164**	**13 088**	**31 120**

HC = head count

Note: The denominations of institutions, territories and countries correspond to their names in 1962, which were used in the original documents of the International Conference of the Organization of the Research and Training in Africa in Relation to the Study, Conservation and Utilization of Natural Resources, organized by UNESCO and UNECA, in Lagos (Nigeria) between 28 July and 6 August 1964.

Source: UNESCO

BOX 8 – LONG-TERM RESEARCH TRENDS IN AGRICULTURAL SCIENCES

Formal agricultural research in Zimbabwe dates back to 1903 when the Department of Agriculture was established. Compared with most other African countries, Zimbabwe had a relatively well developed agricultural research system by the early 1960s.

At the time, the country engaged about 94 researchers per million economically active agricultural population (i.e. those aged 15–65 years who were employed in agriculture), compared with a contemporary average of 15 for sub-Saharan Africa. In terms of research expenditure as a percentage of AgGDP, Zimbabwe spent considerably more than the rest of the continent: 1.81%, compared with a continental average of 0.26% (Pardey, Roseboom and Anderson, 1991).

In a seminal study, Roseboom *et al.* (1995) provided the most comprehensive study ever published of the evolution of the various agricultural research institutions, research personnel and expenditure in Zimbabwe. The study presents long-term trends for a series of indicators for agricultural R&D, including the number of FTE researchers employed in agriculture from 1960 to 1993. Following the same methodological approach, the Agriculture Science and Technology Indicators (ASTI)[20] provides similar data for the period 2000–2008.

Between 1961 and 1992, expenditure on agricultural research increased by 3.5% per year on average, the same growth rate as for government expenditure on the same; expenditure by semi-public institutions grew by 4.2% per year on average and by 6.7% in academia (Roseboom *et al.*, 1995).

Throughout the 1960s and 1970s, the share of total agricultural research funded by government research organizations declined significantly, dropping from about 77% of the total to 70% by 1990 and 56% by 1992. Today, the semi-public research agencies receive the bulk of their funding from the various producer associations, such as the Commercial Grain Producers Association and the Cattle Producers Association. These agencies operate various check-off schemes that are used to finance commodity-specific services. In the case of tobacco, sugar and pigs, the producer associations continue to finance their own research agencies.

Figures 19 and 20 show the evolution in the number of FTE researchers in agricultural sciences and the same per million population. Included are the data on FTE researchers in agricultural sciences obtained by the Zimbabwean government's 2013 survey of R&D (see Table 21).

These figures are consistent with the behaviour shown by other macro-economic data in previous sections (see Figures 4, 5 and 8). The evolution in FTE researchers shown in Figure 19 shows extremely fast growth between independence in 1980 and 1990. No data are available for the period between 1993 and 2001. We can assume, with some confidence, that the fitting curve (dotted line) is a faithful reflection of the trends between 1960 and 2012. The year the curve hits its lowest point coincides with the macro-economic crisis of 2008–2009. After that – according to the government's 2013 survey of R&D – the number of FTE researchers in agricultural sciences begins rising again.

Figure 20 shows the number of FTE researchers in agriculture per million population. Here, it is possible to capture an alternative view. The number of FTE researchers in agricultural sciences per million population peaked in Zimbabwe in 1965 at 35.4. During the war of independence, this number fell to 22 FTE researchers per million population by 1980. After independence, the number rose again to 30.2 by 1986 before slipping back to just 11 in 2007. According to the data

20 ASTI began in 1984 as the Indicator Series Project, a series of extensive surveys of agricultural R&D in all developing countries covering the period 1961–1985. The project was initiated by the International Food Policy Research Institute (IFPRI) and the former International Service for National Agricultural Research (ISNAR). In 2000, the project was renamed ASTI and work continued with funding from the Consultative Group on International Agricultural Research. ASTI is has been facilitated solely by IFPRI since 2004, which is based in Washington DC, USA.

provided by the Government of Zimbabwe in its *National Survey of Research and Development* (Republic of Zimbabwe, 2013d), there are currently 14 FTE researchers in agricultural sciences per million population.

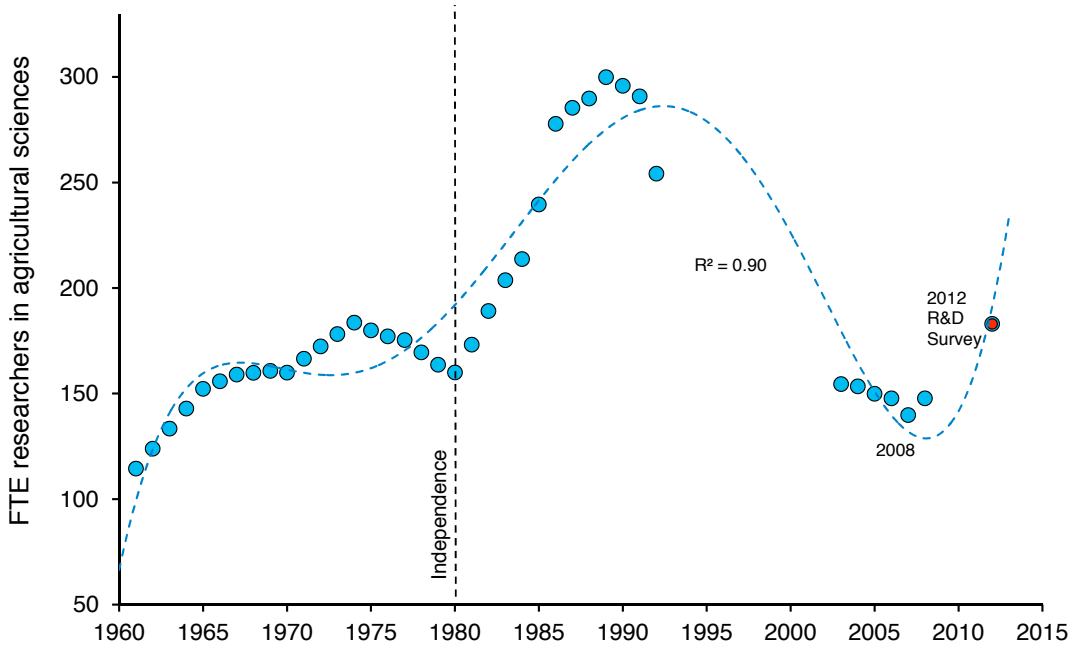


Figure 19: Evolution in number of FTE agricultural researchers in Zimbabwe, 1960–2012. The dotted line represents the best-fitting curve, which in this case has a high correlation coefficient (R2=0.9). Source: UNESCO, based on raw data provided by Roseboom *et al.* (1995), ASTI (2013), Republic of Zimbabwe (2013d)

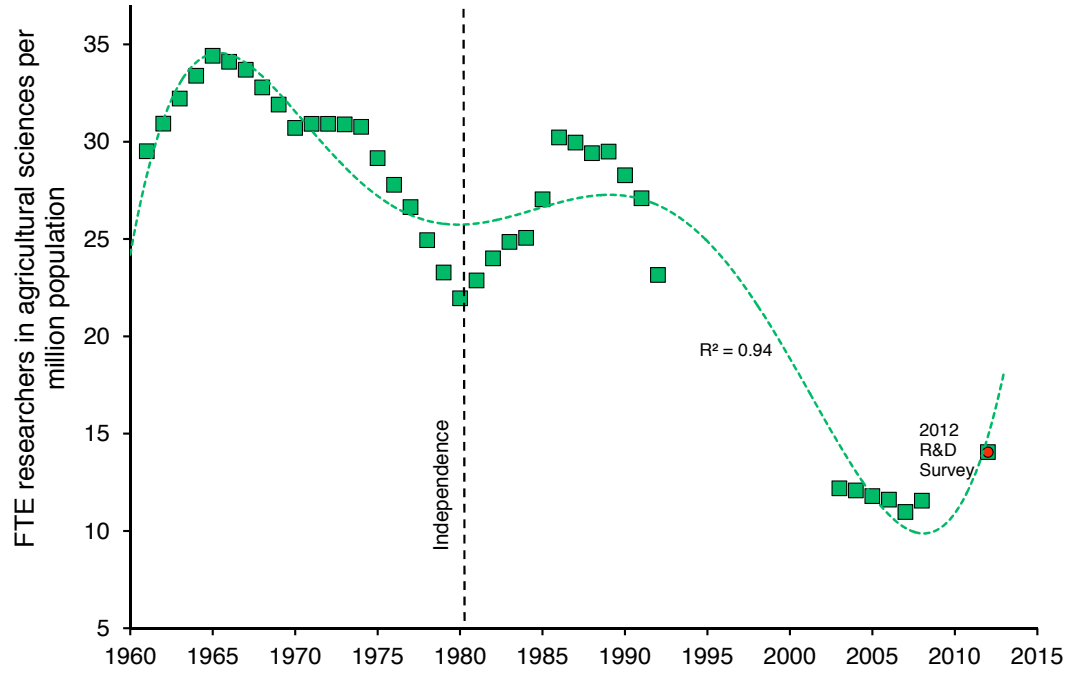


Figure 20: Evolution in number of FTE agricultural researchers in Zimbabwe per million population, 1960–2012. Source: UNESCO, based on raw data provided by Roseboom *et al.* (1995), ASTI (2013), Republic of Zimbabwe (2013d); UN Statistics Division

A scientometric analysis of Zimbabwe

Basic research is usually carried out in universities or other academic institutions. The traditional method of measuring or assessing academic research results uses bibliometric indicators. Bibliometrics is a general term for the inventory and statistical analysis of articles, publications and citations and other more complex indicators of scientific production derived from such statistics. Bibliometric indicators are important tools for assessing R&D, performance and specialization of countries, institutions, laboratories, universities, thematic areas and individual scientists. As with any indicator, it is not faultless and, therefore, should be interpreted with caution.

Furthermore, the procedure for assessing the impact of industrial R&D is essentially based on an analysis of patent statistics and those on trade in highly-tech products, as well as through studies of the technological trade balance for each country.

Both bibliometric analyses and patent statistics are included in a discipline known as scientometrics. At present, thanks to exponential growth in our data-processing capacity, it is possible to prepare sophisticated multidimensional indicators on the production of scientific articles in all disciplines, from exact sciences to humanities. Moreover, very precise analyses can be made of the impact of publications, the state of the art of knowledge in various subject areas in each country, the level of cooperation regarding co-authorship of publications, co-citations, the creation and evolution of scientist networks ('invisible colleges'), etc. By analysing cross-references used in patent applications or by cross-referencing information published in scientific literature, we can use bibliometrics to examine the links between STI and patents (Lemarchand, 2010).

One of the most relevant sources of information about the productivity of scientific knowledge is accessible through international databases (Lemarchand, 2013). This type of information is not usually open access. In particular, a very well-established class of indicators about scientific production can be estimated by counting the number of articles and citations published in mainstream journals. One of the most complete databases is the Web of Science, which includes the Science Citation Index (SCI), Social Science Citation Index (SSCI) and Arts and Humanities Citation Index (A&HCI). The latter is now maintained by Thomson-Reuters, a private company, and covers 12 000 peer-reviewed journals. The other major database is SCOPUS, which is maintained by Elsevier Science and covers 18 000 peer-reviewed journals.

An analysis of the aggregated temporal evolution in the data available at the Web of Science shows a homogeneous trend that is independent of any academic discipline and avoids any substantial change in national trends, owing to the continual incorporation of new journals in the databases. In this way, it is also possible to study the evolution in cooperation patterns among countries and institutions, search for the most developed disciplines and analyse the impact of scientific research on the basis of how other scientists have made use of this material.

Not all Zimbabwean scientists submit their research results to mainstream journals (listed by the Web of Science). Therefore, the existence of local and regional journals in several countries may reflect some peculiar domestic circumstances or specific national scientific agenda that are not considered by the mainstream journals. For this reason, publication in mainstream journals represents only a fraction of the total scientific productivity of any particular country. The main advantage of using these databases is that they have been systematically collected and organized over several decades using similar methodologies, allowing us to perform a long-term analysis with relatively good confidence (Lemarchand, 2012).

In spite of the drawback of underrepresented local and regional journals, it can be argued that there is a good correspondence among SCI, SSCI, A&HCI and other international databases on scientific knowledge production. De Moya-Anegón and Herrero-Solana (1999) and Lemarchand (2012) have shown a strong correlation in the distribution of citable articles between the Science Citation Index Extended and other

databases like PASCAL, INSPEC, COMPENDEX, CHEMICAL ABSTRACTS, BIOSIS, MEDLINE and CAB. They have obtained the following values for the correlation coefficient (R) among the different databases: $0.957 \leq R \leq 0.997$. This finding supports the hypothesis that the combination of SCI, SSCI and A&HCI, listed by the Web of Science database, is a good indicator for any study of mainstream scientific knowledge production and trends in co-authorship networks among different countries.

At this point, it is important to take into account that, during the period analysed here (1966–2013), the number of journals has expanded substantially and, consequently, so the total number of published articles included in the Web of Science database. Mabe (2003) showed that journal growth rates have been remarkably consistent over time, with average rates of 0.034 since 1800 to the present day. This study presents evidences that, during the entire 20th century, these growth phenomena appear to show a system that is self-organizing and in equilibrium, with a 0.032 growth constant. Considering that the Web of Science database only includes a fraction of all the new journals that are published, the growth rate for databases should be even smaller than that estimated by Mabe (2003).

Lemarchand (2012, 2014) has developed a mathematical model showing the proportionality between the size of the national scientific network (e.g. number of FTE researchers in a country) and the corresponding scientific productivity (in terms of the aggregate number of publications per year and the number of co-authored scientific articles between pairs of countries). In this way, the productivity of scientific articles over time is a good proxy for estimating the extent of growth in the number of full-time-equivalent researchers.

SCIENTIFIC PRODUCTIVITY IN THE COLONIAL ERA, 1960–1979

Research in Zimbabwe got under way at the dawn of the 20th century with the creation of an interesting series of research institutions, most of them related to agricultural research. Figure 21 shows the evolution in the number of publications listed in the SCI Expanded, SSCI and A&HCI between 1960 and 1979. The gap observed between 1972 and 1973 has its origin in the characteristics of the Web of Science database[21]. This is due to the fact that no articles listed in the SCI were available between 1960 and 1972. In 1978, Zimbabwe recorded 197 scientific publications in mainstream journals.

Figure 22 shows the number of scientific publications per million population between 1960 and 1979. In 1978, Zimbabwe counted 29 publications per million population, an all-time record.

Table 24 shows Zimbabwe's co-authorship of scientific articles with other countries. It is interesting to observe that, during this period (1960–1979), less than 12% of articles were co-published with other countries. The major partners were the United Kingdom (4.75%), South Africa (2.37%), USA (1.58%) and Australia (0.99%).

Table 25 shows the list of Zimbabwean institutions which account for the production of the scientific publications listed by the Web of Science between 1960 and 1979. The names correspond to the present ones. The University of Zimbabwe was responsible for 65.5% of the total, followed by the Ministry of Agriculture (6.5%), Harare Central Hospital (5.8%), Veterinary Research Laboratory (2.4%) and Department of Veterinary Service (2.4%).

21 According to the information provided by the technical support service of Thomson-Reuters (MD-165137) in February 2007, the complete entries for authors, addresses and countries at the Web of Science have only been available for the SSCI since 1960, for the SCI Expanded since 1973 and for A&HCI since 1975.

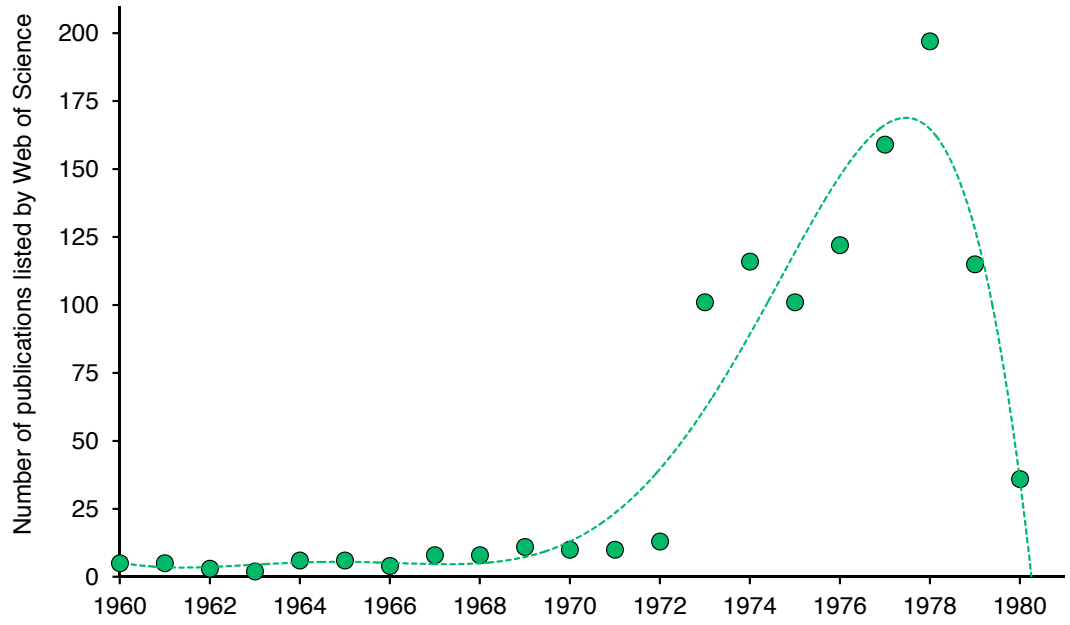


Figure 21: Long-term evolution in number of scientific publications listed by the Web of Science for Zimbabwe, 1960–1979. The dotted line is the best-fitting curve. Source: UNESCO, based on data provided by Web of Science

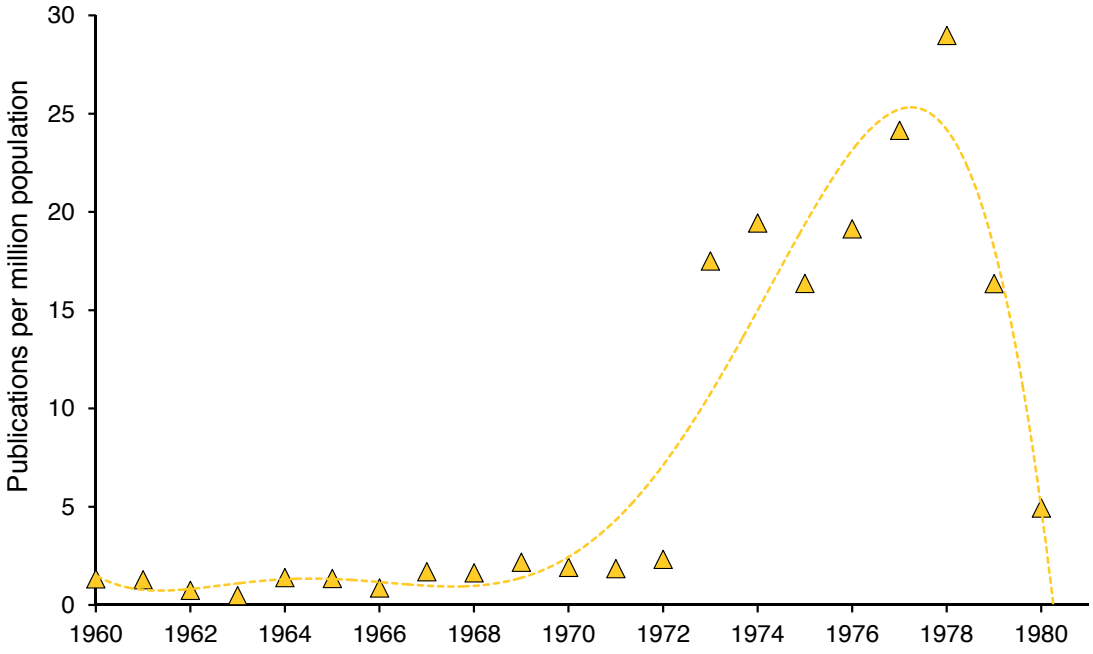


Figure 22: Evolution in the number of scientific publications per million population in Zimbabwe, 1960–1979. The dotted line is the best-fitting curve. Source: UNESCO, based on data provided by the Web of Science and UN Statistics Division

Table 24: Co-authorship of mainstream scientific publications with other countries in Zimbabwe, 1960–1979

1960–1979		
Country	Pub	%
Zimbabwe	1011	100.00
United Kingdom	48	4.75
South Africa	24	2.37
USA	16	1.58
Canada	10	0.99
Australia	3	0.30
Lesotho	3	0.30
Germany	4	0.40
Israel	2	0.20
Netherlands	2	0.20
Gambia	1	0.10
Greece	1	0.10
Hong Kong	1	0.10
Malawi	1	0.10
New Zealand	1	0.10
Switzerland	1	0.10
Zambia	1	0.10

Source: UNESCO, based on data provided by Web of Science

Table 25: Authors' host institution in Zimbabwe for published articles, 1960–1979

Authors' host institution, 1960–1979		
Institution (current name)	N° of publications	Share of total (%)
University of Zimbabwe	662	65.48
Ministry of Agriculture	66	6.53
Harare Central Hospital	59	5.84
Veterinary Research Laboratory	24	2.37
Department of Veterinary Service	24	2.37
National Institute of Health Research	20	1.98
Mpilo Central Hospital	18	1.78
Zimbabwe Parks and Wildlife Management Authority	17	1.68
Plant Protection Research Institute	15	1.48
Tobacco Research Board	12	1.19
Henderson Research Station	11	1.09
Department of Conservation Extension	10	0.99
Crop Breeding Institute	8	0.79
Plant Protection Research Institute	8	0.79
Ministry of Health	6	0.59
Bulawayo Central Hospital	6	0.59
Geological survey	5	0.49

Source: UNESCO, based on data provided by Web of Science

Table 26 presents the distribution of publications over 1960–1979 by sub-field of science. The major sub-fields are general internal medicine (22.2%), agriculture (18.1%), entomology (5.8%) and biochemistry and molecular biology (4.4%). Topics related to medicine and health clearly dominate other sub-fields.

Table 26: Distribution of articles from Zimbabwe listed by the Web of Science, by sub-field, 1960–1979

Scientific articles, 1960–1979		
Sub-fields	N° publications	Share of total (%)
General internal medicine	223	22.19
Agriculture	182	18.11
Entomology	58	5.77
Biochemistry, molecular biology	44	4.38
Public environmental occupational health	38	3.78
Zoology	38	3.78
Veterinary sciences	35	3.48
Area studies	34	3.38
Tropical medicine	32	3.18
Environmental sciences, ecology	31	3.09
Science, technology other topics	29	2.89
Geochemistry, geophysics	25	2.49
Chemistry	22	2.19
Marine freshwater biology	22	2.19
Government law	18	1.79
Pharmacology, pharmacy	17	1.69
Plant sciences	17	1.69
Parasitology	16	1.59
Surgery	16	1.59
Anaesthesiology	14	1.39
Engineering	12	1.19
Business, economics	11	1.10
Gastroenterology, hepatology	11	1.10
Literature	11	1.10
Pediatrics	11	1.10
Physiology	11	1.10
Education, educational research	10	1.00

Source: UNESCO, based on data provided by Web of Science

SCIENTIFIC PRODUCTIVITY POST-INDEPENDENCE, 1980–2013

The number of Zimbabwe's scientific publications listed by international databases (i.e. Web of Science, SCOPUS, etc.) has evolved in recent decades. Zimbabwe occupies the 107th rank in the world and the 16th rank in Africa. Table 27 shows the distribution of mainstream scientific publications, number of citations, citations per article, H index[22], world rank and African rank for 52 African countries.

The total number of Zimbabwe's scientific publications listed by SCOPUS between 1996 and 2012 received 55 075 citations, where 6 025 were self-citations and the average number of citations per article was 10.71. Zimbabwe's H index for this period was 72, placing it 91st in the world.

Figure 23 presents the long-term evolution in the number of scientific articles listed at the SCI Extended, SSCI and A&HCI between 1980 and 2013. The data show that the number of publications grew until reaching a plateau which lasted for 15 years (1990–2004). By 2002, the country had launched its *first* STI policy (see page 89). By 2005, the number of publications had started growing again. By that time, the Ministry of Science and Technology Development had been created and discussions among different stakeholders were taking place in order to define a *second* STI policy (Chetsanga, 2009; Republic of Zimbabwe, 2012a, 2012b) which was published in 2012 (see Box 10).

Figure 24 shows the evolution in scientific articles listed at the SCI Extended, SSCI and A&HCI between 1980 and 2013 per million population. This indicator is a proxy for measuring the level of societal interest in promoting the creation of knowledge. After independence, productivity grew rapidly in Zimbabwe, reaching 23.6 publications per million population by 1982. Generally speaking, productivity decreased between 1982 and 2004, a trend which reversed after 2005. Post-independence productivity peaked in 2012 at 25.3 publications per million population. As shown in Figure 22, the peak during the colonial era was slightly higher, at 29 publications per million population in 1978.

From the data provided by the government's *National Survey of Research and Development* on the number of FTE researchers, each one published an estimated 0.26 scientific articles in mainstream journals in 2012. This is equivalent to each FTE researcher publishing just one article every four years.

Over the years, the specialized literature has tended to assume that there is a high correlation between the number of publications per million population and GDP per capita in different countries (Konrad and Wahl, 1990; Ye, 2007). This correlation has been tested in several empirical studies by applying different mathematical models (i.e. Lemarchand, 2012), including for African countries (i.e. UNESCO, 2013). Figure 25 shows that, in the case of Zimbabwe, this correlation does not exist. This means that any increment (or other type of variation) in one unit of GDP per capita has had no mathematical functional relation with the number of scientific publications per million population. These results can be explained by the absence of financial incentives and adequate policy instruments to promote research and innovation in Zimbabwe. In this way, the evolution in the limited number of scientific publications over time follows the internal dynamics of the individual scientists, who need to publish in order to advance in their career. The observed growth in the number of publications since 2004 relates to the fact that an increasing majority of these articles (over 75%) have been co-published with other countries (see Figure 26 and Table 28).

22 The H index is an indicator of the impact of an individual's scientific output and also, in an aggregate manner, that of institutions and countries (Hirsch, 2005).

Table 27: Distribution of mainstream scientific publications, citations, H index and regional and global ranks for all African countries, 2012

Country	Articles	Citable articles	Citations	Self-Citations	Citations per article	H* index	African rank	World rank
South Africa	13 627	12 766	7 608	2 346	0.56	231	1	34
Tunisia	5 170	4 820	1 152	390	0.22	85	2	52
Nigeria	4 748	4 552	782	230	0.16	89	3	53
Algeria	3 800	3 667	652	196	0.17	78	4	54
Morocco	3 282	3 037	1 753	359	0.53	99	5	56
Kenya	1 725	1 625	1 105	239	0.64	131	6	66
Ethiopia	1 164	1 110	314	107	0.27	73	7	76
Uganda	1 000	947	632	129	0.63	99	8	82
Ghana	981	929	404	96	0.41	73	9	83
Tanzania	902	846	540	177	0.60	93	10	86
Cameroon	850	796	267	63	0.31	72	11	87
Senegal	574	553	216	41	0.38	75	12	96
Sudan	534	509	196	56	0.37	52	13	98
Burkina Faso	449	427	187	61	0.42	62	14	101
Malawi	407	382	276	45	0.68	80	15	103
Zimbabwe	373	358	171	39	0.46	72	16	107
Côte d'Ivoire	365	353	112	22	0.31	68	17	108
Benin	343	324	101	42	0.29	49	18	109
Libya	336	323	75	25	0.22	35	19	110
Zambia	315	291	157	31	0.50	68	20	112
Botswana	290	278	89	8	0.31	57	21	115
Rep. Congo	287	267	136	19	0.47	49	22	116
Madagascar	246	236	115	19	0.47	56	23	121
Mali	225	217	172	29	0.76	55	24	123
Mozambique	191	187	155	28	0.81	53	25	127
Mauritius	184	175	42	11	0.23	41	26	129
Rwanda	177	163	53	11	0.30	36	27	130
Namibia	160	157	79	8	0.49	55	28	131
Gabon	134	124	85	10	0.63	61	29	135
Gambia	126	117	157	19	1.25	80	30	137
Niger	103	98	36	5	0.35	47	31	145
Togo	96	89	17	3	0.18	31	32	149
Swaziland	75	74	35	1	0.47	28	33	155
Angola	63	60	27	9	0.43	25	34	158
Democratic Rep. Congo	57	49	35	1	0.61	28	35	159
Sierra Leone	49	44	15	6	0.31	21	36	162
Guinea	42	38	17	2	0.40	34	37	166
Lesotho	38	37	14	2	0.37	22	38	170
Mauritania	37	36	17	1	0.46	25	39	171
Seychelles	37	34	25	3	0.68	33	40	172

Country	Articles	Citable articles	Citations	Self-Citations	Citations per article	H* index	African rank	World rank
Guinea-Bissau	37	35	38	14	1.03	40	41	173
Central African Rep.	36	36	32	4	0.89	32	42	174
Burundi	33	31	9	0	0.27	24	43	175
Chad	25	20	3	1	0.12	27	44	182
Liberia	22	21	5	1	0.23	14	45	185
Djibouti	20	16	1	0	0.05	13	46	187
Cape Verde	14	14	8	0	0.57	12	47	192
Eritrea	14	13	0	0	0.00	25	48	193
Equatorial Guinea	11	11	11	4	1.00	15	49	196
Somalia	7	6	1	0	0.14	11	50	204
Comoros	6	6	2	0	0.33	10	51	207
Sao Tome and Principe	3	2	0	0	0.00	14	52	217

Source: SCOPUS database (April 2014)

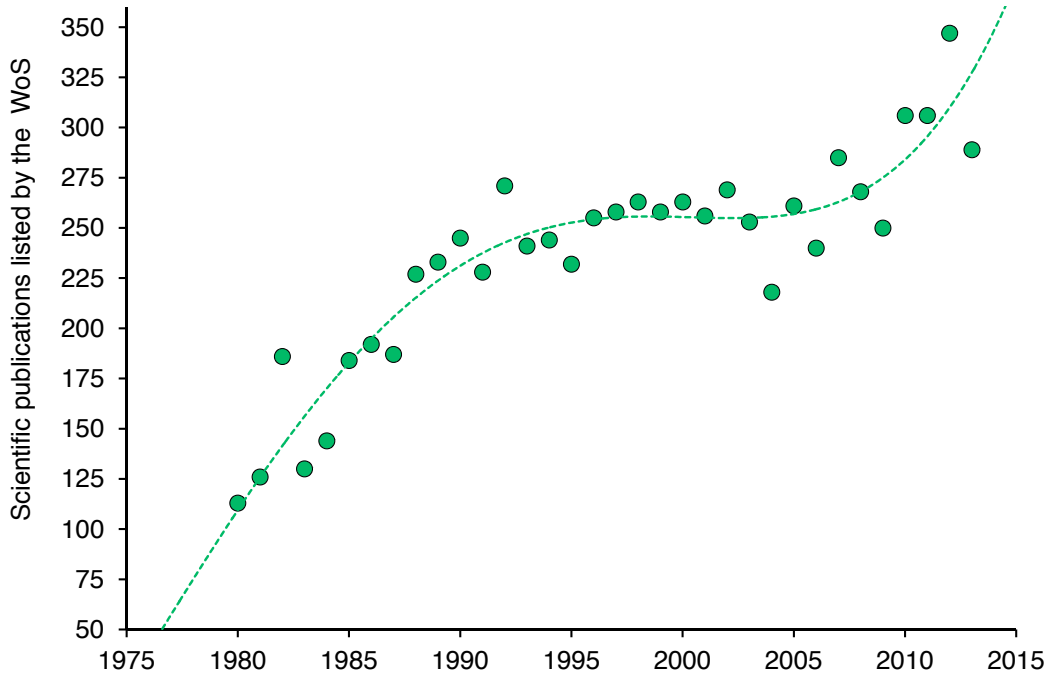


Figure 23: Evolution in the number scientific publications listed by Web of Science for Zimbabwe, 1980–2013. The dotted line indicates the best-fitting curve. Source: UNESCO, based on data provided by Web of Science

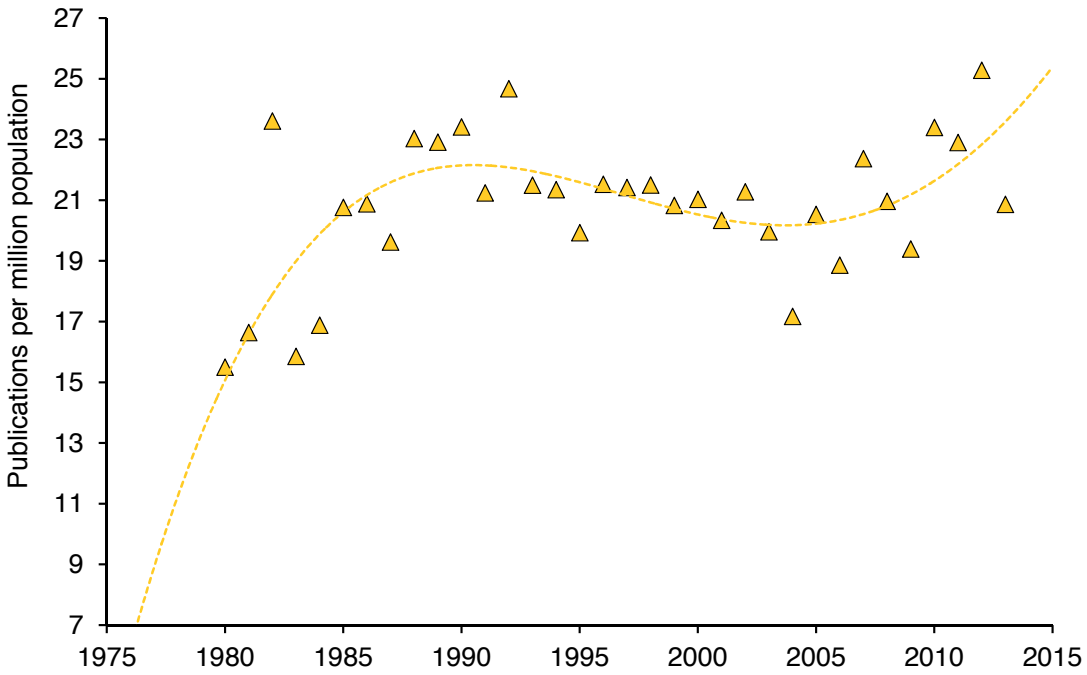


Figure 24: Evolution in the number of scientific publications per million population in Zimbabwe, 1980–2013. The dotted line indicates the best-fitting curve. Source: UNESCO, based on data provided by Web of Science and UN Statistics Division

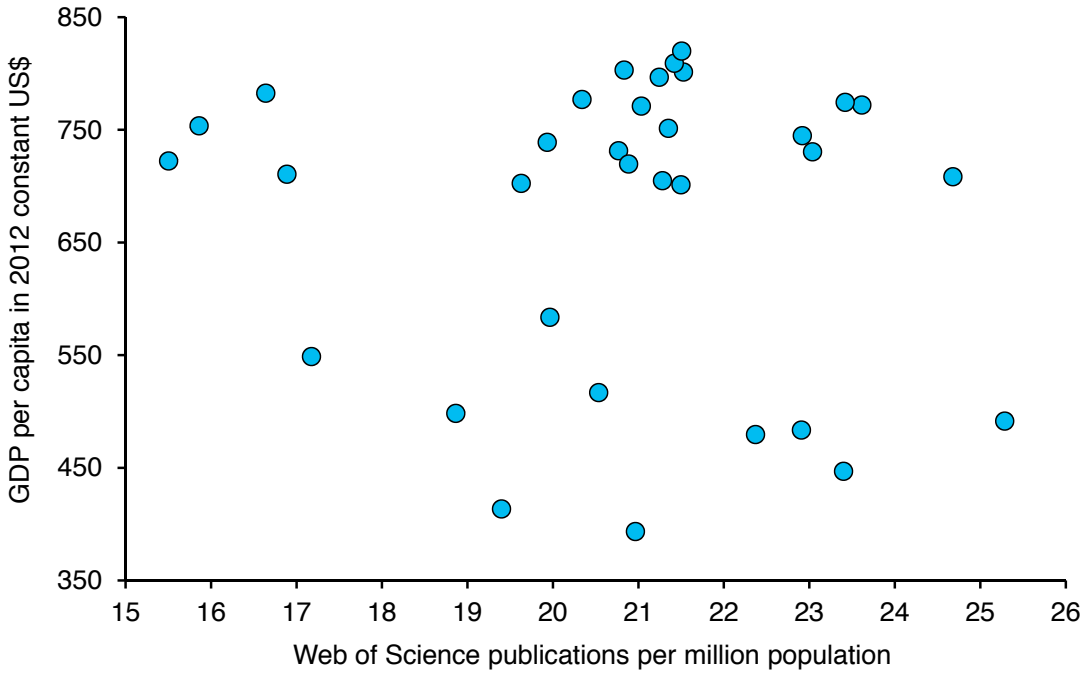


Figure 25: Absence of any correlation between GDP per capita in constant 2012 US$ and the number of scientific publications listed by the Web of Science per million population, 1980–2013. Source: UNESCO

Table 28 shows the distribution of co-authored articles for the 30 most important countries over four different periods. A quick analysis shows how rapidly co-authorship has increased. In the first eleven-year period to 1990, the United Kingdom was the top partner, sharing 6.4% of publications, followed by the USA (5.3%), South Africa (2.6%), Canada (1.3%) and Australia (1.2%). In the period 1991–2001, USA was the top partner (16.02%), followed by the United Kingdom (15.9%), South Africa (5.8%), Netherlands (3.8%) and Kenya (2.6%). Over the third eleven-year period (2002–2012), the top partner was again the USA (21.4%), followed very closely by South Africa (20.6%), the United Kingdom (17.7%), Netherlands (7.1%) and France (5.3%). In 2013, South Africa came top (34.8%), followed by the United Kingdom (25.9%), USA (22.5%), France (8.2%) and Netherlands (7.3%).

The last row of Table 28 shows how co-authorship with African countries has been increasing over time.[23] Figure 26 shows the internationalization of Zimbabwe's publications. In the past decade, between 67% and 83% of all scientific articles with at least one author from Zimbabwe were co-published with authors from abroad.

Table 28: Zimbabwean co-authorship of mainstream scientific publications with other countries, 1980–2013

Rank	1980–1990			1991–2001			2002–2012			2013		
	Country	Pub	Share of total (%)	Country	Pub	Share of total (%)	Country	Pub	Share of total (%)	Country	Pub	Share of total (%)
	Zimbabwe	1971	100.00%	Zimbabwe	2765	100.00%	Zimbabwe	2985	100.00%	Zimbabwe	316	100.00%
1	United Kingdom	126	6.39	USA	443	16.02	USA	640	21.44	South Africa	110	34.81
2	USA	105	5.33	United Kingdom	439	15.88	South Africa	616	20.64	United Kingdom	82	25.95
3	South Africa	52	2.64	South Africa	160	5.79	United Kingdom	529	17.72	USA	71	22.47
4	Canada	25	1.27	Netherlands	106	3.83	Netherlands	213	7.14	France	26	8.23
5	Australia	23	1.17	Kenya	71	2.57	France	157	5.26	Netherlands	23	7.28
6	Netherlands	19	0.96	Sweden	70	2.53	Kenya	131	4.39	Uganda	22	6.96
7	Kenya	18	0.91	France	67	2.42	Uganda	131	4.39	Kenya	19	6.01
8	Italy	11	0.56	Germany	67	2.42	Switzerland	127	4.25	India	17	5.38
9	India	7	0.36	Canada	63	2.28	Malawi	106	3.55	Belgium	15	4.75
10	Switzerland	6	0.30	Switzerland	62	2.24	Denmark	100	3.35	Australia	14	4.43
11	France	5	0.25	Denmark	54	1.95	Zambia	96	3.22	Malawi	14	4.43
12	Ireland	5	0.25	Belgium	50	1.81	Norway	91	3.05	Tanzania	14	4.43
13	Sweden	5	0.25	Australia	49	1.77	Canada	89	2.98	Zambia	14	4.43
14	Belgium	4	0.20	Nigeria	37	1.34	Germany	88	2.95	Italy	13	4.11
15	Nigeria	4	0.20	Norway	33	1.19	Sweden	87	2.91	Brazil	12	3.80
16	Ethiopia	3	0.15	Zambia	31	1.12	Australia	83	2.78	Germany	12	3.80
17	Germany	5	0.25	India	29	1.05	Tanzania	83	2.78	Norway	11	3.48
18	Mozambique	3	0.15	Brazil	24	0.87	Belgium	74	2.48	Sweden	11	3.48
19	Namibia	3	0.15	China	21	0.76	India	64	2.14	Canada	10	3.16
20	Spain	3	0.15	Italy	20	0.72	Botswana	52	1.74	Denmark	10	3.16
21	Sri Lanka	3	0.15	Tanzania	20	0.72	Thailand	48	1.61	Switzerland	10	3.16
22	Zambia	3	0.15	Thailand	20	0.72%	Italy	43	1.44	China	9	2.85
23	Denmark	2	0.10	Malawi	18	0.65%	Nigeria	38	1.27	Botswana	7	2.22

23 The aggregate percentages at regional level (i.e. Africa) are overestimated, owing to the fact that the Web of Science only counts the number of articles which are co-published by pairs of countries (i.e. Zimbabwe with Kenya, Zimbabwe with Botswana, Zimbabwe with Uganda, etc.). Those articles published by authors from three countries will be counted double (i.e. an article by Zimbabwe, Botswana and Kenya), increasing the regional percentage. These figures are only presented as an indicator of the sizeable growth in co-operation among African countries observed in recent years.

Rank	1980–1990			1991–2001			2002–2012			2013		
	Country	Pub	Share of total (%)	Country	Pub	Share of total (%)	Country	Pub	Share of total (%)	Country	Pub	Share of total (%)
	Zimbabwe	1971	100.00%	Zimbabwe	2765	100.00%	Zimbabwe	2985	100.00%	Zimbabwe	316	100.00%
24	Malaysia	2	0.10	Mexico	16	0.58%	Austria	33	1.11	Mexico	7	2.22
25	Saudi Arabia	2	0.10	Ethiopia	14	0.51%	China	32	1.07	Spain	7	2.22
26	Uganda	2	0.10	Botswana	11	0.40%	Mexico	31	1.04	Argentina	6	1.90
27	Argentina	1	0.05	Indonesia	11	0.40%	Ethiopia	30	1.01	Ethiopia	6	1.90
28	Austria	1	0.05	Israel	11	0.40%	Cameroon	29	0.97	Namibia	6	1.90
29	Botswana	1	0.05	Austria	10	0.36%	Brazil	28	0.94	Pakistan	6	1.90
30	Brazil	1	0.05	Poland	10	0.36%	Mozambique	27	0.90	Chile	5	1.58
	Africa	**95**	**4.82**	**Africa**	**445**	**16.09**	**Africa**	**1580**	**52.93**	**Africa**	**238**	**75.32**

Source: UNESCO, based on articles listed at the Science Citation Index Extended, Social Science Citation Index and Arts & Humanities Citation Index

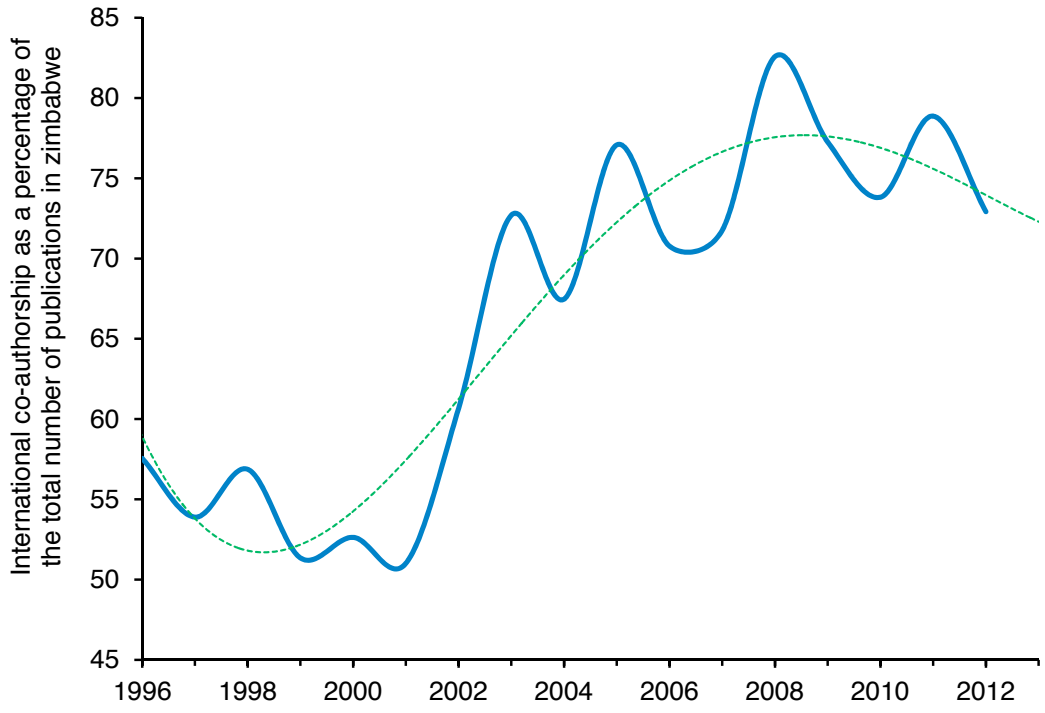


Figure 26: Evolution in international scientific co-authorship as a share of total annual publications in Zimbabwe 1996–2012. The dotted line is the best-fitting curve. Source: UNESCO, based on data provided by Web of Science

Table 29 shows the 25 most productive institutions in Zimbabwe in terms of scientific articles included in the SCI Extended, SSCI and A&CI from 1980 to 2013. Since colonial times, the University of Zimbabwe has been the country's leading institution for the production of scientific articles. Between independence in 1980 and 2013, the University of Zimbabwe produced 58.4% of the country's scientific articles. Between 1980 and 1990, the University of Zimbabwe (62.7%) was followed by the National Institute of Health Research (3.6%) and the Veterinary Research Laboratory (3%). Little changed during the following decade (1991–2001), with the University of Zimbabwe accounting for 62.4% of articles, followed by the National Institute of Health Research (3.2%) and the Veterinary Research Laboratory (2.9%).

New universities and research organizations emerged during the following decade (2002–2012), which was characterized by the drafting of the country's first (2002) and second (2012) STI policies (see page 89). The University of Zimbabwe saw its share of articles drop by 9.2% to 53.2%. Next came the National University of Science and Technology (5.9%) and the Biomedical Research and Training Institute (4.7%).

In 2013, the University of Zimbabwe maintained the lead with 44.3% of all scientific articles, followed by the Bindura University of Science Education (7.3%) and the Biomedical Research and Training Institute (5.4%).

Table 29: Distribution of mainstream scientific publications in Zimbabwe, by national institution and laboratory, 1980–2013

Rank	1980–1990			1991–2001			2002–2012			2013		
	Institution	Pub	Share of total (%)	Institution	Pub	Share of total (%)	Institution	Pub	Share of total (%)	Institution	Pub	Share of total (%)
	Zimbabwe	1971	100.00	Zimbabwe	2765	100.00	Zimbabwe	2985	100.00	Zimbabwe	316	100.00
1	University of Zimbabwe	1 236	62.71	University of Zimbabwe	1725	62.39	University of Zimbabwe	1 589	53.23	University of Zimbabwe	140	44.30
2	National Institute of Health Research	71	3.60	National Institute of Health Research	88	3.18	National Univ. of Science & Technology	175	5.86	Bindura University of Science Education	23	7.28
3	Veterinary Research Laboratory	59	2.99	Veterinary Research Laboratory	79	2.86	Biomedical Research and Training Institute	141	4.72	Biomedical Research and Training Institute	17	5.38
4	Harare Central Hospital	54	2.74	National Univ. of Science & Technology	76	2.75	National Institute of Health Research	141	4.72	National Institute of Health Research	17	5.38
5	Ministry of Agriculture	52	2.64	Ministry of Health	61	2.21	Ministry of Health	99	3.32	National Univ. of Science & Technology	15	4.75
6	Department of Veterinary Serv.	40	2.03	Tsetse Trypanosomiasis Control Branch	48	1.74	Int. Crops Res Inst. for the Semi-Arid Tropics	82	2.75	Ministry of Health	11	3.48
7	Mpilo Central Hospital	39	1.98	Mpilo Central Hospital	32	1.16	Arrupe College	81	2.71	Chinhoyi University of Technology	10	3.16
8	Tobacco Research Board	33	1.67	Parirenyatwa Hospital	29	1.05	Bindura University of Science Education	69	2.31	Int. Crops Res Inst. for the Semi-Arid Tropics	8	2.53
9	Zimbabwe Parks and Wildlife Management Authority	28	1.42	Zimbabwe Parks and Wildlife Management Authority	28	1.01	Zvitambo Project	54	1.81	Zimbabwe Parks and Wildlife Management Authority	7	2.22
10	Ministry of Health	26	1.32	Int. Crops Res Inst. for the Semi-Arid Tropics	27	0.98	Zimbabwe Parks and Wildlife Management Authority	28	0.94	Malilangwe Wildlife Reserve	5	1.58
11	Harare City Health Department	23	1.17	Natl. Herbarium /Natl. Bot Garden	25	0.90	Veterinary Research Laboratory	24	0.80	National Blood Transfusion Service	5	1.58

Rank	1980–1990			1991–2001			2002–2012			2013		
	Institution	Pub	Share of total (%)	Institution	Pub	Share of total (%)	Institution	Pub	Share of total (%)	Institution	Pub	Share of total (%)
	Zimbabwe	1971	100.00	Zimbabwe	2765	100.00	Zimbabwe	2985	100.00	Zimbabwe	316	100.00
12	Gweru Midlands General Hospital	16	0.81	United Bulawayo Hospitals	25	0.90	Matopos Research Station	18	0.60	Zvitambo Project	5	1.58
13	National Blood Transfusion Service	12	0.61	Harare Central Hospital	24	0.87	Nat Hist. Museum Zimbabwe	18	0.60	Great Zimbabwe University	4	1.27
14	Parirenyatwa Hospital	12	0.61	Plant Protection Research Institute	24	0.87	Zimbabwe Open University	18	0.60	Hwange National Park	4	1.27
15	Int. Crops Res Inst. for the Semi-Arid Tropics	9	0.46	Nat Hist. Museum Zimbabwe	21	0.76	Harare City Health Department	15	0.50	Africa University	3	0.95
16	Lake Kariba Fisheries Research Institute	9	0.46	Ministry of Agriculture	20	0.72	Chem. Soil Res Inst.	13	0.44	Harare City Health Department	3	0.95
17	National Museum	8	0.41	Africa University	15	0.54	Chinhoyi University of Technology	13	0.44	Med Res Council Zimbabwe	3	0.95
18	Chem. Soil Res Inst.	7	0.36	National Blood Transfusion Service	15	0.54	Parirenyatwa Hospital	13	0.44	Zimbabwe Open Univ.	3	0.95
19	Dept. Clin. Pharmacol.	7	0.36	Tobacco Research Board	15	0.29	Africa University	12	0.40	Gov. Veterinary Services	2	0.63
20	Henderson Research Station	7	0.36	Chem. Soil Res Inst.	14	0.51	Med Res Council Zimbabwe	12	0.40	Nat. Hist. Museum Zimbabwe	2	0.63
21	Int. Lab Res Anim. Diseases	7	0.36	Grasslands Research Station	12	0.43	Great Zimbabwe University	11	0.37	Parirenyatwa Hospital	2	0.63
22	Plant Protection Research Institute	7	0.36	Sengwa Wildlife Research Institute	9	0.33	Department of Veterinary Service	9	0.30	Zimbabwe Research Council	2	0.63
23	Mana Pools Natl. Park	6	0.30	Geological Survey Zimbabwe	8	0.29	Ministry of Agriculture	9	0.30	Zimbabwe Revenue Author	2	0.63
24	Colin Saunders Hospital T/a Triangle Hospital	6	0.30	Chiredzi Research Station	7	0.25	National AIDS Council	9	0.30	Centre Sexual Health HIV-AIDS Res Zimbabwe	2	0.63
25	Hwange National Park	5	0.25	Bulawayo Cent Hosp.	6	0.25	National Blood Transfusion Service	9	0.30	Harare Institute of Technology	1	0.32

Source: UNESCO, based on Web of Science articles

Table 30 presents the ten most important foreign and international research organizations which are responsible for co-authoring scientific articles listed at the SCI Extended, SSCI, and A&HCI. As observed in the previous tables, the diversification of institutions and the amount of co-publications haveincreased over time. The most important collaborative ties established over a period of decades were with the University of London, University of Florida, University of California, University of Witwatersrand, University of Utrecht, University of Kwazulu Natal and the University of Pretoria, among others. In the past decade, collaboration has grown with research centres and universities in South Africa.

Figure 27 shows the distribution of publications (1996–2012) for the six main research fields (UNESCO, 1978 and OECD, 2002): agricultural sciences; art and humanities; engineering and technology; natural and exact sciences; medicine and health sciences and; social sciences. This figure has been organized this way, in order to allow a comparison with R&D input indicators, such as the number of graduates (i.e. Figure 15), the number of researchers by field of science (i.e. Table 21) or R&D expenditure by field of science.

Figure 27 shows that, over the past two decades, most research articles have related to medicine and health sciences (around 40%), whereas agricultural sciences and natural and exact sciences account for around 20% of the total. The share of publications on subjects related to engineering and technology has oscillated between 6% (2004) and 2% (2012), whereas social sciences have represented between about 4% (2000) and 14% (2012) of publications.

Table 30: Top ten foreign research institutions and centres co-authoring articles with Zimbabwean scientists, 1980–2013

Rank	1980–1990			1991–2001			2002–2012			2013		
	Institution	Pub	Share of total (%)	Institution	Pub	Share of total (%)	Institution	Pub	Share of total (%)	Institution	Pub	Share of total (%)
	Zimbabwe	1971	100.00	Zimbabwe	2765	100.00	Zimbabwe	2985	100.00	Zimbabwe	316	100.00
1	University of London	24	1.22	University of Florida	94	3.40	University of California	320	10.72	University of London	39	12.34
2	University of Witwatersrand	11	0.56	University of London	84	3.04	University of London	187	6.26	University of California	36	11.39
3	CSIRO	10	0.51	University of California	79	2.86	World Health Organization	174	5.83	University of Kwazulu Natal	27	8.54
4	University of Utrecht	10	0.51	University of Oxford	60	2.17	University of Witwatersrand	123	4.12	University of Witwatersrand	23	7.28
5	University of Florida	10	0.51	World Health Organization	60	2.17	Johns Hopkins University	122	4.09	University College of London	20	6.33
6	University of Bristol	8	0.41	Florida State University	51	1.84	Imperial College of London	114	3.82	University of Pretoria	19	6.01
7	University of Nairobi	8	0.41	University of Utrecht	42	1.52	London School of Hygiene	107	3.58	London School of Hygiene	18	5.70
8	South African Inst. Med. Res.	7	0.36	Imperial College of London	32	1.16	University of Pretoria	97	3.25	Midlands State University	18	5.70
9	University of Cape Town	7	0.36	International Livestock Research Institute	30	1.08	University of Cape Town	90	3.02	University of Cape Town	17	5.38
10	University of Kwazulu Natal	7	0.36	University of Witwatersrand	29	1.05	University of Kwazulu Natal	86	2.88	Imperial College of London	16	5.06

Source: UNESCO, based on articles listed at the Science Citation Index Extended, Social Science Citation Index and Arts & Humanities Citation Index

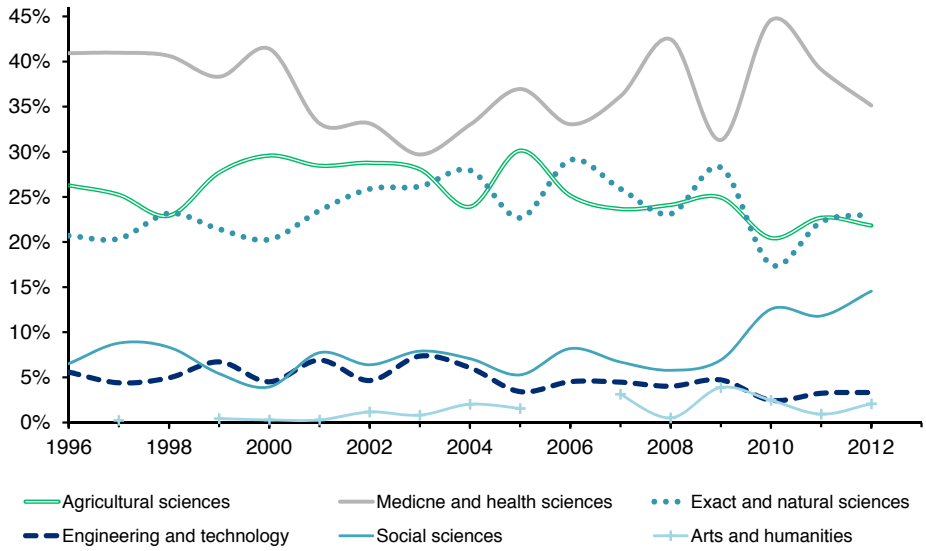


Figure 27: Distribution of publications in Zimbabwe by field of science, 1996–2012. Source: UNESCO estimation based on SCOPUS data

Table 31 analyses in detail the distribution of articles against 30 different sub-fields of science for four different periods: 1980–1990; 1991–2001; 2002–2012 and 2013. It is very clear that medicine and agriculture are the most important research fields in the country over the 34-year period shown. Thre is a total lack of research articles in more technological oriented fields like new materials, applied physics, space sciences or nanotechnology. The last two were selected as priorities by the *Second Science, Technology and Innovation Policy* (Republic of Zimbabwe, 2012a).

Table 31: Distribution of mainstream scientific articles in Zimbabwe by sub-field, 1980–2013

Rank	1980–1990			1991–2001			2002–2012			2013		
	Sub-fields	Pub	Share of total (%)	Sub-fields	Pub	Share of total (%)	Sub-fields	Pub	Share of total (%)	Sub-fields	Pub	Share of total (%)
	Zimbabwe	1971	100.00	Zimbabwe	2765	100.00	Zimbabwe	2985	100.00	Zimbabwe	316	100.00
1	Medicine general internal	524	26.59	Medicine general internal	253	9.15	Infectious diseases	370	12.40	Infectious diseases	41	12.97
2	Agronomy	127	6.44	Veterinary sciences	249	9.01	Immunology	301	10.08	Immunology	31	9.81
3	Veterinary sciences	114	5.78	Public environmental occupational health	220	7.96	Public environmental occupational health	278	9.31	Multidisciplinary studies	30	9.49
4	Public environmental occupational health	109	5.53	Agriculture dairy animal science	117	4.23	Water resources	205	6.87	Ecology	26	8.23
5	Tropical medicine	101	5.12	Plant sciences	117	4.23	Ecology	175	5.86	Public environmental occupational health	24	7.59
6	Agriculture multidisciplinary	94	4.77	Tropical medicine	115	4.16	Geosciences multidisciplinary	174	5.83	Veterinary sciences	19	6.01
7	Ecology	76	3.86	Agronomy	111	4.01	Meteorology atmospheric sciences	158	5.29	Agronomy	14	4.43

Rank	1980–1990			1991–2001			2002–2012			2013		
	Sub-fields	Pub	Share of total (%)	Sub-fields	Pub	Share of total (%)	Sub-fields	Pub	Share of total (%)	Sub-fields	Pub	Share of total (%)
	Zimbabwe	1971	100.00	Zimbabwe	2765	100.00	Zimbabwe	2985	100.00	Zimbabwe	316	100.00
8	Entomology	74	3.75	Immunology	108	3.91	Tropical medicine	150	5.03	Biodiversity conservation	12	3.80
9	Zoology	61	3.09	Ecology	103	3.73	Veterinary sciences	148	4.96	Water resources	12	3.80
10	Parasitology	54	2.74	Infectious diseases	91	3.29	Agronomy	139	4.66	Environmental sciences	11	3.48
11	Plant sciences	51	2.59	Environmental sciences	89	3.22	Environmental sciences	125	4.19	Microbiology	11	3.48
12	Pharmacology pharmacy	48	2.44	Parasitology	85	3.07	Microbiology	116	3.89	Social sciences biomedical	11	3.48
13	Area studies	47	2.38	Entomology	83	3.00	Virology	104	3.48	Tropical medicine	11	3.48
14	Anthropology	38	1.93	Microbiology	82	2.97	Medicine general internal	90	3.02	Medicine general internal	10	3.16
15	Religion	36	1.83	Pharmacology pharmacy	74	2.68	Parasitology	89	2.98	Virology	10	3.16
16	Multidisciplinary studies	34	1.73	Geosciences multidisciplinary	69	2.50	Agriculture dairy animal science	88	2.95	Environmental studies	9	2.85
17	Planning development	34	1.73	Food science technology	68	2.46	Plant sciences	86	2.88	Geosciences multidisciplinary	9	2.85
18	Physiology	32	1.62	Zoology	66	2.39	Religion	86	2.88	Plant sciences	9	2.85
19	Public environmental occupational health science	30	1.52	Public environmental occupational health science	61	2.21	Philosophy	82	2.75	Biology	8	2.53
20	Infectious diseases	29	1.47	Biochemistry molecular Biology	56	2.03	Zoology	75	2.51	Agriculture multidisciplinary	7	2.22
21	Agriculture dairy animal science	28	1.42	Social sciences biomedical	51	1.84	Agriculture multidisciplinary	68	2.28	Agriculture dairy animal science	6	1.90
22	Geosciences multidisciplinary	28	1.42	Soil science	49	1.77	Multidisciplinary studies	67	2.24	Anthropology	6	1.90
23	Obstetrics gynaecology	28	1.42	Area studies	43	1.56	Pharmacology pharmacy	66	2.21	Food science technology	6	1.90
24	Biochemistry molecular Biology	27	1.37	Economics	42	1.52	Soil science	65	2.18	Health policy services	6	1.90
25	Neurosciences	27	1.37	Geochemistry geophysics	42	1.52	Food science technology	63	2.11	Haematology	6	1.90
26	Philosophy	27	1.37	Agriculture multidisciplinary	41	1.48	Social sciences biomedical	63	2.11	Parasitology	6	1.90
27	Geography	22	1.12	Multidisciplinary studies	41	1.48	Biodiversity conservation	60	2.01	Meteorology atmospheric sciences	5	1.58
28	Mathematics	21	1.07	Obstetrics gynaecology	40	1.45	Psychology multidisciplinary	56	1.88	Psychology multidisciplinary	5	1.58
29	Psychology social	21	1.07	Surgery	38	1.37	Obstetrics gynaecology	52	1.74	Respiratory system	5	1.58
30	Endocrinology metabolism	20	1.01	Nutrition dietetics	37	1.34	Public environmental occupational health science	49	1.64	Social sciences interdisciplinary	5	1.58

Source: UNESCO, based on articles listed at the Science Citation Index Extended, Social Science Citation Index and Arts & Humanities Citation Index

WHAT PATENTS TELL US ABOUT RESEARCH AND INNOVATION

A patent is a document issued by an authorized governmental agency which grants the right to exclude anyone else from the production or use of a specific new device, apparatus, or process for a stated number of years (see glossary, page 203). The grant is issued to the inventor of this device or process after an examination that focuses on both the novelty of the claimed item and its potential utility.

Measuring the linkage between publications and patents has been a subject of academic research in recent decades. It helps us to understand the intensity and orientation of research, as well as the sources of the relation between science and technology. At the meso-level, a measurable relation allows us to investigate knowledge transfers and potential spillovers: describing the knowledge base of particular technologies; conversely, to disclose the technological neighbourhood of scientific themes or research fronts or the migration of topics in the innovation process, for example from research to technology then on to commercialization.

A patent constitutes a milestone in the progress of a given technology. However, it is only one piece in a larger puzzle of technological innovation which entails combining new knowledge with a suitable business strategy and other factors to achieve commercial success. Patent data have been widely used in many innovation studies (Griliches, 1990). Next to patent count data, it is obvious that patent documents, because of legal reporting requirements, provide the STI policy expert with a wealth of information which can be used for various types of foresight study and strategic analysis. For instance, typical patent documents contain the names and the addresses of the inventors and their applicants, as well as references to other scientific and technological documents. This information can easily be used to map progress and collaboration in technological fields, as well as to assess the vitality of various organizations (firms as well as universities) in a particular field of technological development or in a particular system of innovation.

The kind of economic studies in which patent statistics have been used include the long-term changes in the amount and direction of inventive output in particular industries; the relationship between these changes and other long-term economic indicators; the relative efficiency of company-financed and government-financed industrial R&D; the contribution of individual firms to particular areas of innovative activity; the relative significance of foreign and home-generated technology and; for measuring individual inventive output.

Patent analysis takes many forms, with important distinctions between macro- and micro-analyses (Trippe, 2003). In the private sector, for instance, intellectual asset management groups probe deeply to understand the development of individual technologies through a systematic mapping of the content of patents. From the perspective of SETI policy studies, the methodological approach has recourse to the macro-analysis. This analysis focuses on studying the patenting patterns at national level, combined with bibliometric research.

Patent offices and regional bodies

Aggregate patent statistics are usually classified in a variety of ways and have been compiled since the late 19th century. Studies of patent statistics are generally based on information produced by international databases. The most relevant databases are United States Patents and Trademark Office (USPTO), Japan Patent Office (JPO) and European Patent Office (EPO). This is so because these offices are based in highly industrialized countries, which consequently have a higher likelihood of transforming the patent claims into an innovation.

In 1974, the World Intellectual Property Organisation (WIPO) became a specialized agency of the United Nations system with a mandate for administering intellectual property matters, compiling and publishing global statistics on patents, trademarks and industrial designs.

The African Regional Intellectual Property Organization (ARIPO), formerly the African Regional Industrial Property Organization, is an intergovernmental organization fostering cooperation among African states in patenting and other intellectual property matters. ARIPO was established by the Lusaka Agreement of 1976. It has the capacity to hear applications for patents and registered trademarks in its member states which are parties to the Harare (patents) and Banjul (marks) protocols. ARIPO also features a protocol on the protection of traditional knowledge, the Swakopmund Protocol, signed in 2010 by nine of ARIPO's member states. As of May 2014, the protocol had not yet entered into force (see page 169).

Even though patent grants can be thought of as a moving average of past applications, statistical studies reveal that the figures for granted patents tend to fluctuate as much, or more, than the number of patent applications. It is also clear that economic conditions impinge on the rate at which patents are applied for (Griliches, 1990). Any analysis of long-term temporal series of patents will reflect the innovation behaviour of a particular country and the stage of national development at different epochs, as well as any economic, political and societal crisis along the way.

Analysing patent trends in Zimbabwe

Figure 28 overleaf shows the evolution between 1960–2002 in patent applications and grants for residents and non-residents of Zimbabwe (see Annex 2 for a glossary of related terms). The vertical axes in Figure 28 (a) and (b) use a logarithmic scale. Consequently, in this type of graph, a straight line represents an exponential curve. On the one hand, Figure 28 (a) and (b) shows that the number of patent applications and granted patents involving non-residents decreased exponentially over time. On the other hand, the number of patent applications and granted patents involving residents reflects the diverse crises that Zimbabwe has been through at different epochs. These curves are consistent with trends in the local productive sector, the lack of endogenous industrial innovation and the absence of incentives for entrepreneurship and commercialization of research results.

Table 32 shows the number of patent applications filed and patents granted abroad by Zimbabwean residents (1994–2012) at a foreign office. Figure 29 presents the distribution of patent applications for Zimbabwe (1998–2012) by top field of technology.

Over the period 1991–2010, Zimbabwe had only six patents applications presented at both USPTO and EPO, out of a total of 1 757 and 954 applications respectively presented by all the countries of the African Union.

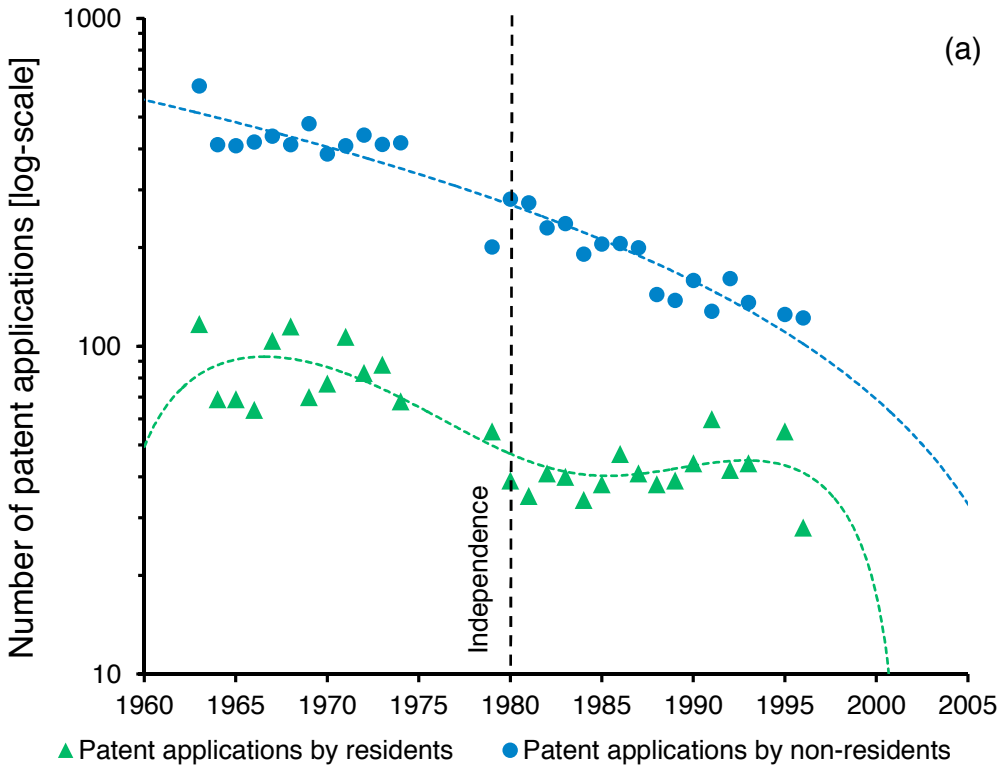


Figure 28a: Evolution in patent applications in Zimbabwe by residents (triangles) and non-residents (circles), 1960–2002. The dotted lines are the best-fitting curves. The vertical axes are expressed in logarithmic scales. Source: UNESCO, based on data provided by WIPO

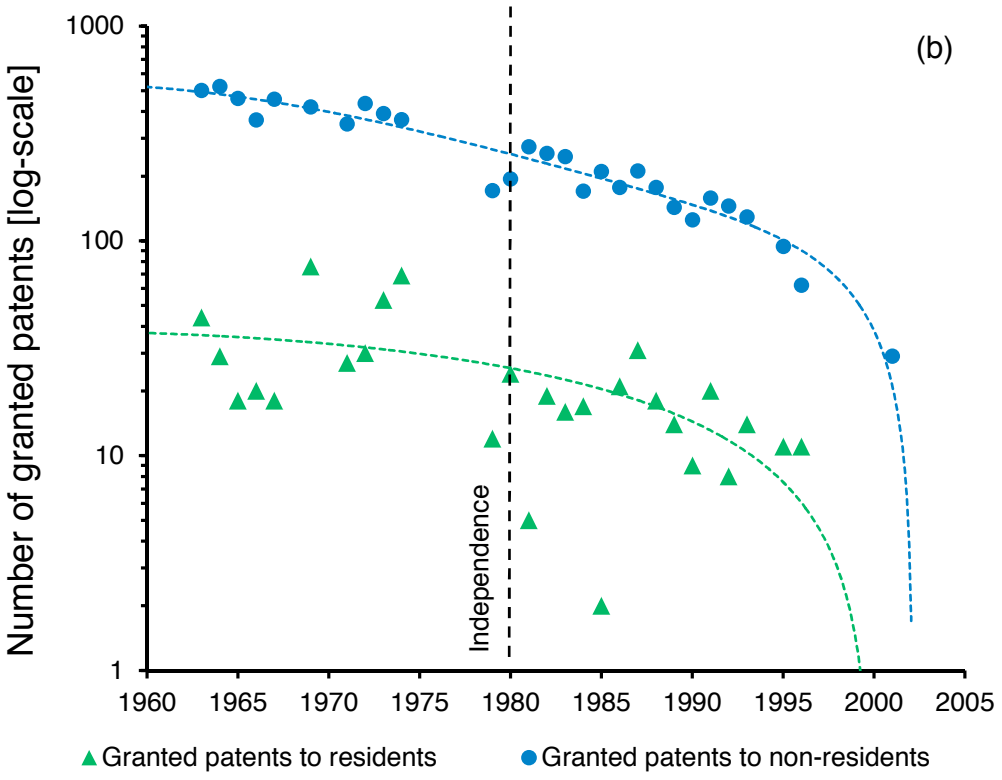


Figure 28b: Evolution in patents granted in Zimbabwe to residents (triangles) and non-residents (circles), 1960–2002. The dotted lines are the best-fitting curves. The vertical axes are expressed in logarithmic scales. Source: UNESCO, based on data provided by WIPO

Table 32: Number of patent applications filed and patents obtained abroad by Zimbabwean residents, 1994–2012

Year	Patent applications filed abroad by residents	Patents granted abroad to residents
1994*	6	
1995*	1	
1996*	3	
1997*	3	
1998*	1	
1999*	1	
2000§	3	
2001§	2	
2002§	2	
2003§	4	6
2004§	8	2
2005§	1	1
2006§	3	1
2007§	2	2
2008§	2	9
2009§	5	5
2010§	2	3
2011§	6	133
2012§	5	1

Source: (*) African Regional Industrial Property Organization (ARIPO) and (§) WIPO

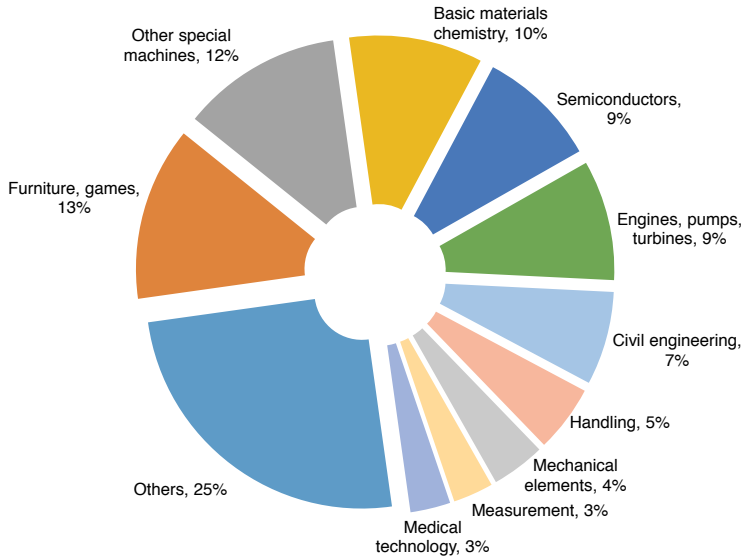


Figure 29: Patent applications filed abroad by Zimbabweans, by top field of technology, 1998–2012. Source: WIPO

What trademark data reveal about innovation

Recently, trademark data have also been used to convey information on two key aspects of innovation which are not usually covered by traditional indicators: marketing innovation and innovation in the services sector (Millot, 2009). Different empirical studies have shown the link between trademark counts and other indicators of innovation performance, when available. For instance, trademark numbers at the firm level have been found to correlate positively with innovation as reflected in responses to innovation surveys, with R&D (for certain industries), with patents, and with the number of new product launches. This correlation is particularly high in knowledge-intensive services and in high-tech sectors like the pharmaceutical industry. A further advantage of trademarks as a source of data is their broad availability and relatively easy accessibility.

A trademark is a sign capable of distinguishing the goods or services of one enterprize from those of other enterprises. Trademarks are protected by intellectual property rights. In principle, a trademark registration will confer an exclusive right on the use of the registered trademark. This implies that the trademark can be used exclusively by its owner, or licensed to another party for use in return for payment. Registration provides legal certainty and reinforces the position of the right holder, for example, in case of litigation. The term of registration can vary but is usually ten years. It can be renewed indefinitely on payment of additional fees. Trademark rights are private rights and protection is enforced through court orders.

The link between trademark deposits and product innovation is relatively straightforward: the commercialization of new products is sometimes associated with the creation of a new trademark in order to communicate about the innovation and, later, possibly become the reference on the market for the product, which in turn enables firms to appropriate the benefits of their innovation. When it comes to marketing innovation, the link with trademark deposits is more complex.

Data on trademarks are available for Zimbabwe from 1960 onwards. Figure 30 shows the evolution in trademark applications by residents and non-residents between 1960 and 2002. The vertical axis has a logarithmic scale. The behaviour of both types of application follows a parabolic shape with a vertex around the independence date. For the non-resident applications, the parabola has its vertex at a minimum value of 600 and the maximum values at the left- and right-hand extremes with approximately 1 400 applications. For the resident applications curve, the parabola has its vertex at a minimum value of 200 and maximum values at the left- and right-hand extremes with around 600 applications.

Table 33 shows the number of trademark applications filed by residents, non-residents and abroad between 1998 and 2012, as well as the number of registrations. The substantial drop in trademarks applications and registrations following the decrease in industrial activity shown in previous sections.

Lastly, Table 34 shows the recent evolution in the number of applications and registrations concerning industrial designs in Zimbabwe.

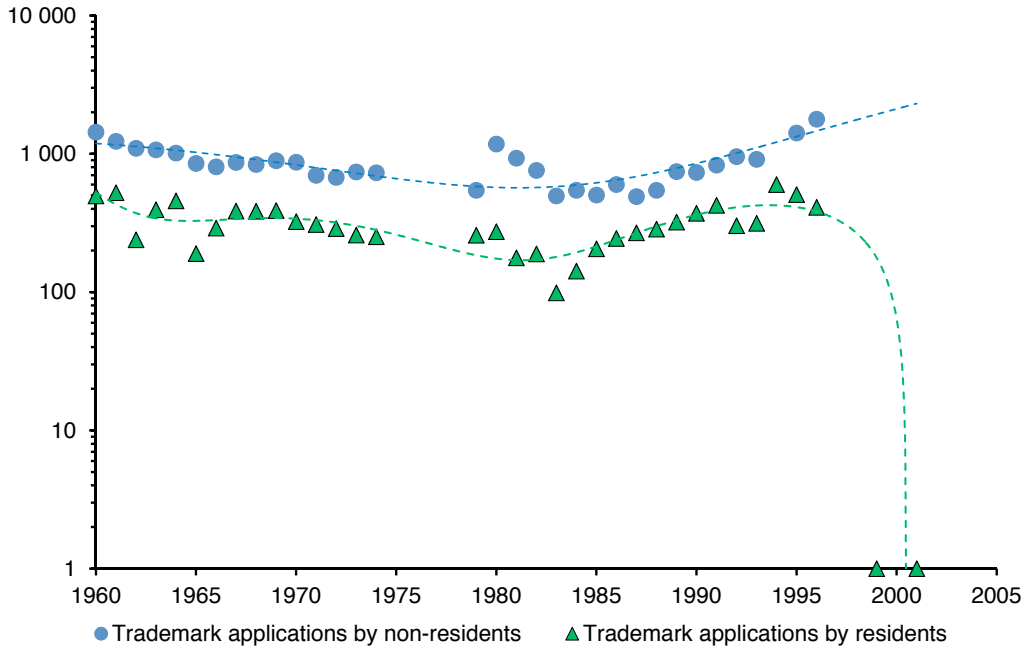


Figure 30: Evolution in the number of trademark applications in Zimbabwe, 1960–2002. The dotted lines are the best-fitting curves. The vertical axis is expressed in logarithmic scale. Source: UNESCO, based on data provided by WIPO

Table 33: Trademark applications and registrations involving residents and non-residents in Zimbabwe and filed/obtained abroad, 1998–2012

Year	Trademark Applications			Trademark Registrations		
	Residents	Non-residents	Filed abroad by residents	Residents	Non-residents	Obtained abroad by residents
1998		31			8	
1999	1	13	26		32	
2000			5			
2001	1	17	8 972	2	18	
2002			25			
2003			44			15
2004			17			1
2005			7			
2006			19			
2007						
2008			1			5
2009			22			9
2010			168			16
2011			15			17
2012			22			17

Source: WIPO

Table 34: Industrial design applications and registrations involving residents and non-residents in Zimbabwe and filed/obtained abroad, 1998–2012

Year	Industrial Design Applications			Industrial Design Registrations		
	Residents	Non-residents	Filed abroad by residents	Residents	Non-residents	Obtained abroad by residents
1998	11	5			3	
1999		3			4	
2000						
2001		14			8	
2002						
2003			2			
2004						
2005						
2006			1			
2007						
2008						
2009			1			
2010			1			1
2011			2			
2012						5

Source: WIPO

Historical background to SETI policies in Zimbabwe

AGRICULTURE: MAINSTAY OF THE ECONOMY FOR OVER A CENTURY

Since the colonial period, agriculture has been the main economic sector in Zimbabwe. As early as 1903, the Department of Agriculture was established and with it the country's research activities. In those days, agricultural research was confined to testing newly introduced plants and conducting simple agronomic investigations designed to improve the local performance of the most promising crops, such as tobacco, coffee, cotton and maize. In 1909, the Department of Agriculture established the Salisbury Experimental Station. Over the next 40 years, an extensive network developed of research stations, experimental farms and testing and demonstrations stations (Roseboom *et al,* 1995).

In 1928, the Rhodesia Agricultural Union formed the Rhodesia Tobacco Association (for tobacco growers). After experiencing production of low-quality tobacco which found no market in Britain and South Africa, the Tobacco Association established a research farm in Marandellas (now Marondera) to carry out research on all aspects of tobacco farming. In those days, the association was desirous to play a greater role in the scientific production of tobacco. The government supported the research and some farmers also donated funds for market research. During this period, other research institutions were founded, such as the Cotton Research and Industry Board (CRIB) and the Pig Industry Board (PIB).

In 1935, the Tobacco Research Board was officially constituted by an act of Parliament to supervise research in connection with tobacco (see Box 9). The Tobacco Research Board would develop a major research programme of its own, taking over the research conducted by the Department of Agriculture, as well as the tobacco research station at Trelawney.

Following a major reorganization of the Ministry of Agriculture and Lands, the Department of Research and Specialist Services was created in 1948, along with the Department of Forestry and Lands, the Department of Irrigation and the Department of Veterinary Services (Roseboom *et al,* 1995). The Department of Research and Specialist Services initially included the following branches: Tobacco, Chemistry, Animal Husbandry, Crop Production, Horticulture, Dairying, Poultry, Pasture Research, Botany and Plant Pathology, Entomology and Conservation and Extension.

In 1961, the Federation of Rhodesia and Nyasaland (today's Zimbabwe, Zambia and Malawi) established the Agricultural Research Council of Central Africa with substantial support from the British government. Modelled on the Agricultural Research Council of East Africa, the council rapidly established its own research activities and facilities in each member country alongside national research facilities. In Zimbabwe, the council established research units that focused on soil productivity, cotton pest control and tsetse fly biology. This latter unit was located at the University College of Rhodesia and Nyasaland. The break-up of the federation in 1963 eventually led to the disbanding of the council in 1967. In Zimbabwe, most of the council's research activities and facilities were assumed by the Department of Research and Specialist Services.

In an effort to streamline its rather fragmented structure, the Department of Research and Specialist Services was reorganized in 1968. The number of branches were reduced to six, namely: Crop Production, Animal Production, Biology and Ecology, Chemistry and Soils, Plant Protection and Agricultural Education.

Commercial farmers in Zimbabwe have a long history of organized producer associations dealing with commodities such as tobacco, coffee, cotton, oilseeds, grains, cattle, dairy, poultry, sheep and timber. Together, these associations formed the Rhodesia National Farmers Organisation Union, which was renamed the Commercial Farmers' Union in 1981. These producer associations lobbied the government to reorganize the agricultural research activities of the Department of Research and Specialist Services along commodity lines based on the example set by the Tobacco Research Board. The government resisted this pressure, however, on the grounds that this would lead to overlapping research interests and an excessive duplication of effort (Saunder, 1978).

BOX 9 – A BRIEF HISTORY OF THE TOBACCO INDUSTRY IN ZIMBABWE

In Zimbabwe, agriculture contributes about 18.5% of GDP and 33% of foreign exchange earnings. It is the source of formal employment for 23% of the population.

Zimbabwe is the largest producer of tobacco leaf in Africa and the world's fourth-largest producer of flue-cured tobacco, after China, Brazil and the United States of America. Tobacco production normally accounts for more than 50% of agricultural exports, 30% of total exports and nearly 10% of GDP. Farming and marketing methods have been refined to the point where Zimbabwe is a world leader in tobacco production in terms of quality and research.

Tobacco was grown as a subsistence crop in Zimbabwe, even before the arrival of the British in the 1880s. Africans used to grow it around their kraals in small and irregular patches. It was the European settlers who introduced large-scale tobacco farming and globalized the tobacco trade in the late 19th century.

In the 1903–1904 season, tobacco was grown on more than 100 farms. The crop suffered from disease and lack of expert curing, problems which persisted in later years. Growers exported tobacco to South Africa then later to Britain but suffered economic loss (particularly in 1928) owing to the poor quality of their tobacco. In late 1928, the Rhodesia Agricultural Union formed the Rhodesia Tobacco Association (for tobacco growers), which became the voice of the tobacco industry.

In 1950, a delegation from the Tobacco Marketing Board met with the British Tobacco Advisory Council in London, where it was agreed that British manufacturers would buy a maximum quantity of 140 000 000 lb of Rhodesian tobacco. This tobacco was supposed to meet Britain's quality standards. This made growers realize the need for research to improve tobacco farming and marketing. They agreed to take charge of their own affairs and strive to produce a high-quality product and better marketing methods. The Rhodesia Tobacco Association established a research farm in Marondera (formerly Marandellas) to carry out research on all aspects of tobacco farming. The association was keen to play a greater role in identifying markets and the scientific production of tobacco but needed greater funding to do so. For the farmers, the responsibility for conducting tobacco research fell to the government. The government did indeed support tobacco research, with the researchers working as civil servants, but it also took control of research by the same token. In parallel, some farmers donated funds for market research.

In 1933, a cess, or levy, was imposed on all tobacco-growers under the terms of the Tobacco Levy Act of the same year: 1/20th of a penny had to be paid on every pound of tobacco exported. The levy was imposed to raise funds for market research. The certainty of a regular income strengthened the association, enabling it to embark on a long struggle to wrest control of tobacco research from the government and ensure an independent status for those who took over control.

The Rhodesia Tobacco Association lobbied the Department of Agriculture to create an advisory board focused exclusively on tobacco research. In 1935, the Tobacco Research Advisory Board was officially constituted by an Act of Parliament. The board consisted of two representatives of tobacco-buyers and two growers, plus the Chief Tobacco Officer and the Director of Agriculture, who acted as chairperson. The board was the sole advisor to the Minister of Agriculture on the land, buildings and other facilities considered necessary for tobacco research; it made recommendations on staff appointments, initiated and approved all tobacco research projects and issued calls for progress reports on the latter.

Tobacco research stations at Trelawney, Karoi, Shamva (for fire-cured tobacco) and Chipinge were set up to carry out tobacco research under different soil and climatic conditions in regions suitable for tobacco-growing.

Marketing problems were especially acute during the depression of the 1930s. In 1934, there was such a surplus that 20% of each grower's crop was removed from the open market and later disposed of privately – even destroyed, in some cases. By 1935, it had become apparent to both growers and buyers that a more orderly marketing system was desirable. Under pressure from

a growers' organization, legislation was subsequently introduced which led to the promulgating of the Tobacco Marketing and Levy Act in 1936. The act provided for the founding of the Tobacco Marketing Board (now the Tobacco Industry and Marketing Board) and the compulsory sale of tobacco through auction floors.

In 1938, the Tobacco Research Act was passed; it defined tobacco research (entomology, plant pathology, chemistry, agronomy and engineering). Farmers were dissatisfied with the progress of tobacco research carried out by the Department of Agriculture and continued lobbying for tobacco research to be given to the Tobacco Research Advisory Board instead, in keeping with the terms of the Tobacco Research Act of 1938. The official date for handing over research to the Tobacco Research Board was fixed at the board's inauguration on 1 August 1950.

From the outset, the Tobacco Research Board employed well-trained researchers from abroad and sent its own researchers abroad for further training abroad. Today, it still employs well-qualified researchers who use modern scientific methods to solve problems faced by the tobacco-growing industry and to improve the yield and quality of tobacco. The board maintains the tradition of holding tobacco field days and organizing radio discussions, conferences and visits to research stations. To this day, it trains new tobacco growers and publishes a journal/bulletin and technical handbook to share information with the tobacco industry.

Over more than half a century, the Tobacco Research Board has established a worldwide reputation for tobacco research in the service of the tobacco industry. Most research is conducted at the Kutsaga Research Station, originally known as 'Koala' Research Station. 'Kutsaga' is a fitting name. It is an anglicized derivative of the Shona word *tsvaga*, meaning to seek, search, hunt or look for. The official opening of Kutsaga Research Station took place in 1954, following completion of the building complex. This complex has stood the test of time and is still beautiful today with state-of-the-art laboratories, a library, administrative offices, greenhouses, etc. The acquisition and development of the Kutsaga Research station represent the finest example of self-help in Rhodesia, for tobacco farmers contributed two-thirds of the cost of research work and associated capital expenditure.

Over the years, the Kutsaga Research Station has contributed tremendously to Zimbabwe's scientific and educational institutions, in general, and to Zimbabwe's tobacco industry, in particular. The Tobacco Research Board has continually produced improved varieties with resistance to nematodes, viruses, bacteria and fungi. Methods to combat these tobacco pests keep evolving. Suitable crop rotations for different soils and fertilizers have been developed and regularly modified, as have tobacco flue-curing methods. The Tobacco Research Board has exclusive rights to flue-cured tobacco research in Zimbabwe, in keeping with the provisions of the Tobacco Research Act (Chapter 18:21) of 1950.

Three types of tobacco have traditionally been grown in Zimbabwe: Virginia flue-cured, burley and oriental tobacco. Flue-cured tobacco constitutes more than 95% of tobacco yield. All tobacco varieties sold in Zimbabwe must be recommended by the Tobacco Research Board. Furthermore, all agrochemicals used on tobacco must be countenanced by the Tobacco Research Board before use, in accordance with the Tobacco Marketing and Levy Act. The expert advice from the Tobacco Research Board and enthusiasm of farmers have brought about a marvelous change in atmosphere throughout the tobacco industry in the wake of the land reform in Zimbabwe.

There were in excess of 105 000 tobacco-growers in 2013, compared to 82 833 in 2012. Today, the government is still collecting the tobacco levy (0.001% of tobacco sales), which is put in a specific account to fund the activities of the Tobacco Research Board (which receives 75%) and Tobacco Industry and Marketing Board (25%). This account is managed jointly by the government, Tobacco Research Board and Tobacco Industry and Marketing Board. The Tobacco Research Board is now also funded from the proceeds of its own commercialization of seeds and fertilizer, among other products, which it sells directly to farmers.

Source: Dr Wilson Parawira, Dean of the Faculty of Science, Bindura University of Science Education, Zimbabwe

Note: The information in this box has been adapted from various sources, including Tanser (1991)

In 1970, the national authorities established an Agricultural Research Council with strong representation from commercial farmers' associations. The other members of the council were the directors of the Department of Research and Specialist Services and the Tobacco Research Board, together with representatives of the University of Zimbabwe and agro-industry. The council was set up essentially as an advisory body "to keep under review and to promote agricultural research in Rhodesia" (Saunder, 1978).

In 1975, the government significantly modified the Agricultural Research Council's role and mandate, giving it more direct control over the country's agricultural research agenda by making available, as a grant to the council, some of the public funds earmarked principally for the research activities of the Department of Research and Specialist Services and of the Institute of Agricultural Engineering. In 1982, the government restored the Agricultural Research Council to its former advisory role and created a separately administered Agricultural Research Fund with grants received from producer associations and donors. This significantly reduced the influence of the commercial farmers in setting the Department of Research and Specialist Services' research agenda, while opening the way for it to focus more on the problems faced by farmers in the communal areas (Roseboom *et al*, 1995).

In response to this development, in 1982, the Commercial Oilseed Producers' Association and the Commercial Grain Producers' Association created the Agricultural Research Trust. The trust operates as an independent research, demonstration and training organization for commercial farmers and is not bound by government regulations and objectives. In 1986, the Zimbabwe Cereal Producers' Association joined the Agricultural Research Trust, followed by the Cattle Producers' Association in 1993. Today, the trust employs a director and five professional and technical officers supported by two technicians and 120 junior staff who are mostly housed on the Trust Farm (see page 155).

The Department of Research and Specialist Services has been in operation since 1948, although it has been reorganized and renamed several times, as we have seen. Following the land reform which took place in Zimbabwe in 2000 and the subsequent shift in the structure of the country's agriculture sector, several institutional changes have occurred in an effort to meet the demand for research services and new technologies. In 2001, the Department of Research and Specialist Services was merged with the former Agricultural Technical and Extension Services Department (AGRITEX) to become the Department of Agricultural Research and Extension (AREX). In 2007, the research arm of AREX was transformed into the Department of Agriculture Research for Development (DAR4D). Two years later, following the Global Political Agreement that ushered in Zimbabwe's government of national Unity, DAR4D reverted to its original denomination of the Department of Research and Specialist Services (Flaherty *et al*, 2011).

THE DEVELOPMENT OF CENTRES OF LEARNING AND RESEARCH

The Rhodesia University College was established in 1953. Two years later, the college was incorporated into the University College of Rhodesia and Nyasaland. For many years, the college maintained a special relationship with the Universities of London and Birmingham in an effort to ensure high academic standards. In 1970, the Rhodesia University College became fully independent and was renamed the University of Rhodesia. Ten years later, it received its present name, the University of Zimbabwe.

In 1962, UNESCO conducted a survey of research centres in 41 African countries, including Zimbabwe (see Box 7). The study revealed the existence of 14 research units devoted to agriculture and three devoted to medicine, four associated with natural museums, six with university departments and a further four associated with a polytechnic institute, geological research centre, meteorological institute and a hydrological research unit.

This survey included the Geological Survey (est. 1910) but not the Institute of Mining Research, which would only be established at the University of Zimbabwe in 1969. To this day, the Institute of Mining Research blends research with further education, training and consultancy services. In 2012, for instance, it embarked on a collaborative research project with the Chamber of Mines and the Platinum Producers Committee.

Also surveyed by UNESCO in 1962 was the Blair Research Institute, founded in 1939 as the research arm of the Ministry of Health and later an affiliate of the University of Zimbabwe. The Blair Research Institute became a prestigious institution, developing the Blair toilet (or pit latrine) which revolutionized sanitation in many African countries. It is also known for designing a bush pump which became the national standard hand pump in Zimbabwe in 1989. In 2011, it was renamed the National Institute of Health Research.

Centres of excellence in specialized fields of research include the Scientific Industrial Research and Development Centre, Tobacco Research Board, Gwebi, Chibero, Henderson, Matopos, Kadoma Cotton, Grasslands, the Forestry Industry, Veterinary Services and the Department of Research and Specialist Services. Founded in 1993, the Scientific and Industrial Research and Development Centre comprises 11 specialized institutes, the activities of which span biotechnology, building technology, electronics, energy technology, the environment, remote-sensing, food and biomedical sciences, metallurgy, information and communication technology, metrology and production engineering.

The Zimbabwe Academy of Sciences dates from 2004. It counts 87 Fellows grouped into three colleges: life sciences, physical sciences and social sciences (see page 134).

Today, a number of state and private universities have a mandate to promote SETI in Zimbabwe. Among the state-run universities are: the oldest and biggest of these, the University of Zimbabwe (est. 1953); National University of Science and Technology (est. 1991); Midlands State University (est. 1998); Great Zimbabwe University and Zimbabwe Open University (both est. 1999); Bindura University of Science Education (est. 2000); Chinhoyi University of Technology (est. 2001); Lupane State University (est. 2004); Harare Institute of Technology (est. 2005) and Gwanda State University, due to open in 2014.

Private universities include the Africa University (est. 1992), Catholic University (est. 1998), Women's University in Africa (est. 2002), Reformed Church University and Zimbabwe Ezekiel Guti University (est. 2012). Plans to establish two new universities are at an advanced stage.

The following polytechnics also promote SETI: Harare, Bulawayo, Mutare, Gweru, Masvingo, Kwekwe, Kushinga Phikelela and Joshua Nkomo Polytechnics. There are also two industrial training colleges: Msasa Industrial Training College and Westgate Industrial Training College. There are three vocational training colleges: Ponesai Vanhu Technical College, Danhiko Project and the School of Mines. Some of these polytechnics have broadened their scope as part of their metamorphosis into state provincial universities within the next five years. Under this programme, the polytechnics in Mutare, Kwekwe, Masvingo and Harare are at an advanced stage of attaining university status.

The first decade of the 21st century was plagued by an economic crisis that, even today, threatens to roll back the huge strides made in the education sector. The main problems currently experienced are: high staffing vacancy rates, especially in the Faculties of Engineering, Sciences and Medicine, where an estimated 70% of posts on average lie vacant; and a loss of skilled human resources from the region, owing to brain drain and gender imbalances. COMESA (2011) identifies other challenges, including inadequate funding and outdated infrastructure and equipment.

GOVERNMENT STRATEGIES TO PROMOTE ACADEMIC RESEARCH AND INDUSTRIAL INNOVATION

In order to promote innovation during the colonial era, the authorities promoted the founding of the Rhodesia Iron and Steel Commission as a state agency, the establishment of the Cotton Industry and Research Board and the creation of the Industrial Development Corporation of Zimbabwe as a state enterprise. Wholly owned by the government, the corporation has played a commercial role since its inception in 1963, as it is also registered under the Companies Act of Zimbabwe. A review of this period considered that there was an 'almost complete absence of technological development' (Scientific Liaison Office, 1983).

Between 1965 and 1980, there was no explicit S&T policy document. Hove and Zinyama (2012) consider that, during this period, technological growth occurred not as a result of deliberate action but rather as a reaction to exogenously determined factors which stressed the economy while posing challenges to the entire government machinery.

In 1967, the then Prime Minister of Rhodesia, Ian Smith, established the Scientific Liaison Office in the Office of the Prime Minister. The office was tasked with the duty of advising the Prime Minister on scientific matters. The office retained its advisory role in an independent Zimbabwe. In 1986, the office gave birth to the Research Council of Zimbabwe. One of its major functions was to advise the government on all matters relating to S&T and to co-ordinate research undertaken by sectorial research councils and institutes. In carrying out its mandate, the Research Council of Zimbabwe collaborated with both private and public sectors. It was served by a small secretariat from the Scientific Liaison Office in the Office of the President and Cabinet.

Research and innovation appeared on the institutional agenda in 1981, when the then Prime Minister R.G. Mugabe stated that 'the government will speed up the development of S&T … to promote industrialization' (Government of Zimbabwe, 1981).

Hove and Zinyama (2012) consider that the aims of government policy for the development of the first S&T policy proposal were set forth in the *Growth with Equity* policy statement of February 1981. In this document, the government announced its intention of coming up with an explicit national S&T policy to guide efforts to build the country's technological capabilities (Hove and Zinyama, 2012). During the 1981 Zimbabwe Conference on Reconstruction and Development, the officials stated that the 'government proposes to review as a matter of urgency the provisions of the Research Act and promulgate a new Science and Technology Act with a view to establishing necessary and appropriate institutions in this field.' In their study, Hove and Zinyama (2012) showed that the last point was reiterated several times in the *Transitional Development Plan* (1982–1985) and first (1986–1990) and second (1991–1995) *Five Year Development Plans*. This pattern has been observed in several countries after independence (i.e. UNESCO, 2013).

For the promotion of sustainable development, any effective policy should co-ordinate policies on higher education and research (SETI supply side) with industrial policy (SETI demand side), through a set of incentives or policy instruments put in place by the government. The Government of Zimbabwe realized that no industrial policy had ever even formulated. The latter was the responsibility of the Ministry of Industry and Commerce. Hove and Zinyama (2012) showed that it took the ministry 19 years to produce this industrial policy, in March 1999. According to the authors, the absence of an industrial policy created co-ordination problems when it came to formulating a research and innovation policy.

THE COUNTRY'S FIRST *SCIENCE AND TECHNOLOGY POLICY*

Zimbabwe's first *Science and Technology Policy* was launched on 5 June 2002, following wide consultations with experts from all the key sectors of the economy – including government ministries, parastatals and the private sector. The ultimate objective of the policy was to provide a comprehensive framework within which the country could promote S&T and harness it to economic development. The policy also sought to co-ordinate and direct R&D activities.

The overall objective of the first *Science and Technology Policy* was to promote national scientific and technological self-reliance by ensuring: (a) rapid and sustainable industrialization through R&D that focused on import substitution; (b) adequate food production and shelter that utilized appropriate, affordable technologies; (c) a good health delivery system that used R&D to explore both modern and traditional medicines; (d) environmentally sound development programmes; (e) provision of sufficient energy resources using S&T to exploit renewable and non-renewable sources of energy and; (f) sustained employment creation.

As a way of promoting R&D, the first *Science and Technology Policy* put the following incentives in place for industry and individuals to promote research (what is known as operational policy instruments): (a) government budgetary allocation; (b) a double deduction on expenses incurred in promoting research; and (c) tax deduction on donations to R&D institutions of up to Z$20 million (for 2003).

A second policy was launched in 2012 (see Box 10). This *Second Science, Technology and Innovation Policy* takes cognisance of the new technological developments available to address emerging national challenges.

ESTABLISHMENT OF THE DEPARTMENT OF SCIENCE AND TECHNOLOGY

In August 2002, a Department of Science and Technology was established in the Office of the President and Cabinet with the ultimate objective of enhancing national economic growth and development through the systematic application of S&T to meet national development challenges.

The overall functions of the Department of Science and Technology Development, as it is now known, are to: (i) co-ordinate the formulation of S&T development policies; (ii) co-ordinate S&T issues across all sectors; (iii) assist in the establishment and rationalization of centres of innovation and in the production of S&T, in line with the Research Act; (iv) assist in building capacity for the local production of specified import substitution goods; (v) promote public awareness of S&T; (vi) promote scientific and ICT literacy to enhance Zimbabwe's competitiveness in the global economy; (vii) create databases on R&D performed in Zimbabwe and to enhance linkages and collaboration with regional and international counterparts and; (viii) develop a regulatory framework for S&T.

The Department of Science and Technology Development has identified five priority areas for immediate attention through collaborative efforts with relevant and interested strategic partners. These are: (i) rapid industrialization; (ii) R&D focused on import substitution; (iii) fast-tracking ICTs; (iv) building human capital through science education, and; (v) popularizing S&T.

THE MINISTRY OF SCIENCE AND TECHNOLOGY DEVELOPMENT (2005–2013)

In November 2003, the African Ministerial Council on Science and Technology (AMCOST) was created under the auspices of the African Union (AU) and its New Partnership for Africa's Development (NEPAD). This high-level forum for AU Ministers of Science and Technology has been seeking ever since to develop policies and priorities in STI for African development.

In the wake of this important new regional strategy, the Government of Zimbabwe decided to create its own Ministry of Science and Technology Development in 2005. The vision of the new ministry was: 'to make science and technology an integral part of both individual and national development'. The mission statement read as follows, 'to provide an enabling environment in which science and technology thrive with a view to intensify[ing] national development.'

The Ministry of Science and Technology Development comprised the following departments: (1) Science, Technology and Innovation, Promotion and Integration; (2) Research, Development and Innovation; (3) Commercialisation of Research and Development and Innovation and; (4) Administration Finance and Human Resources. The ministry's three main focus areas were: (i) the R&D taking place in research institutes, universities and in industry; (ii) the commercialization of output from R&D that would lead to industrialization and; (iii) the creation of a science culture at the individual and national levels.

The Cabinet Committee on Scientific Research, Technology Development and Application never became functional. It was to have been chaired by the Minister of Science and Technology Development. The committee was originally intended to be composed of several ministers from the Ministry of National Security in the President's Office, Ministry of Information Communication Technology, Ministry of Small and Medium Enterprises and Cooperative Development, Ministry of Youth Development, Indigenisation and Empowerment, Ministry of Energy and Power Development, Ministry of Defence, Ministry of Women's Affairs, Gender and Community Development, Ministry of Public Service, Ministry of Industry and Commerce, Ministry of Regional Integration and International Cooperation, Ministry of Transport, Communications and Infrastructural Development, Ministry of Agriculture, Mechanisation and Irrigation Development, Ministry of Media, Information and Publicity, Ministry of Education, Sport and Culture, Ministry of Higher and Tertiary Education, Ministry of Finance, Ministry of Economic Planning and Investment and Ministry of State Enterprises and Parastatals.

In January 2005, the Ministry of Science and Technology Development announced[24] the launch of an Innovation and Commercialisation Fund to promote research and innovation. Under the scheme, selected projects are funded by the ministry up to the point of commercial production, after which the beneficiaries are required to pay the monies received back into the fund for subsequent lending to other innovators. In 2012, the government set aside US$1.5 million for disbursement through the Ministry of Science and Technology Development on a competitive basis, according to the minister of the time, Heneri Amos Murima Dzinotyiwey. In an interview, he explained that 'the fund is used to support research on projects in areas like nanotechnology, energy, water and indigenous knowledge systems and technologies. Proposals can come from anyone but they are evaluated by an independent scientific committee. At the beginning of each year, we advertise for applications to this fund in local newspapers and urge people in industry to pair up with researchers and institutes and collaborate in their proposals.' The minister went on to say that, 'through these ICF-funded projects, we have identified a communication gap between entrepreneurs and researchers. Researchers tend to stay too much in the laboratory and they don't engage with the outside world. So we're also organizing workshops on patenting for researchers to encourage more scientific contributions to come to the fore. We do not lack clarity or determination. But we do desperately lack funds' (TWAS, 2012).

The Innovation and Commercialisation Fund figures in the *Implementation Plan for the Second Science, Technology and Innovation Policy of Zimbabwe* published in 2012. Under the third primary goal, that of the commercialization of research results, several activities and indicators are listed for the fund. One indicator concerns the number of ICF projects funded and their percentage contribution to GDP, including repayments made to the fund. The Innovation and Commercialisation Fund still exists today.

The Ministry of Science and Technology Development was disbanded in 2013 after the harmonized elections and has since become the Department of Science and Technology within the Ministry of Higher and Tertiary Education, Science and Technology Development. The new government has also replaced the *Medium Term Plan 2011–2015* with the *Zimbabwe Agenda for Sustainable Socio-economic Transformation, 2013–2018* (see page 17).

The S&T-related services and R&D activities supported by the government fall into three groups: (a) cross-sectorial generic technologies, sciences and associated human resources, for which the Ministry of Higher and Tertiary Education, Science and Technology Development is responsible; (b) focused, sectorial and relatively mature technologies, which are primarily the responsibility of sector-specific ministries, with the ministry's involvement in the R&D aspects especially; and (c) standard technology-based services, for which sectorial ministries are wholly responsible.

For details of many of the SETI-related institutions mentioned above, see the inventory beginning on page 112.

24 See: www.scidev.net/global/news/zimbabwe-launches-fund-to-promote-innovation.html

BOX 10 – UNESCO'S REVIEW OF STI POLICY IN ZIMBABWE, 2008–2014

UNESCO's Division of Science Policy and Capacity-Building has been collaborating with the Government of Zimbabwe since 2008 through the Spanish Fiduciary Fund allocated to the project for Capacity-Building in STI Policy in Africa.

In April 2008, the Ministry of Science and Technology Development addressed an official request to UNESCO for technical assistance in reviewing the national STI system and implementing the country's *Science and Technology Policy,* launched in 2002 (see page 89).

In September 2008, UNESCO ran a first sub-regional workshop for all SADC countries on STI policies and indicators, in collaboration with the African Union Commission. The workshop was hosted by the Botswana Ministry of Communication, Science and Technology and moderated by UNESCO staff, including specialists from the UNESCO Institute for Statistics. Zimbabwe's presentation during the workshop of an ongoing review of its national S&T system served as the basis for defining a roadmap for co-operation during a parallel bilateral meeting with UNESCO.

In November 2008, the Hon. O.D. Muchena, the then Minister of Science, Technology and Development, addressed a specific request to UNESCO for technical support in reviewing the national *Science and Technology Policy,* the first step being the preparation of a status report on the national STI system. Following the positive reply from the UNESCO Director General, a contract was established with the Zimbabwe Academy of Sciences through the UNESCO Harare Cluster Office. The draft status report was revised by staff from UNESCO's Division of Science Policy and Sustainable Development then presented to a national workshop in August 2009. A team led by Chistopher Chetsanga, President of the Zimbabwe Academy of Sciences, completed the report in October 2009. The report was officially launched in August 2010, in the presence of UNESCO officials (Chetsanga *et al.*, 2009).

The second step in co-operation with UNESCO was agreed upon via an official letter from the UNESCO Assistant Director-General for Natural Sciences, Walter Erdelen, in January 2010. The ministry chose an international expert to support the process and, in February 2011, the draft implementation strategy and main content of the revised policy, the *Second Science, Technology and Innovation Policy,* were presented.

In June 2012, the *Second Science, Technology and Innovation Policy* was launched by H.E. R. G. Mugabe, President of Zimbabwe, who thanked UNESCO for its support in formulating the policy. In the preface, he wrote that 'the publication of this *Science and Technology Policy* represents a milestone of innovation in Zimbabwe. This policy also aims at developing a more effective innovative system of partnering all institutions involved in creating new knowledge, producing new innovations and diffusing them to the benefit of the people of Zimbabwe and our region at large'.

The *Implementation Plan for the Second Science, Technology and Innovation Policy of Zimbabwe* was also finalized with UNESCO support.

The *Second Science, Technology and Innovation Policy* has six primary goals:

- Strengthen capacity development in science, technology and innovation.
- Learn and utilize emerging technologies to accelerate development.
- Accelerate commercialization of research results.
- Search for scientific solutions to global environmental challenges.
- Mobilize resources and popularize science and technology.
- Foster international collaboration in science, technology and innovation.

UNESCO subsequently organized a first sub-regional workshop on surveys of STI policy, policy instruments, governing bodies and indicators, in Harare on 7 and 8 November 2012, in co-operation with the Ministry of Science and Technology Development. The objective was to introduce civil servants from Botswana, Malawi, Mozambique, Zambia and Zimbabwe to a UNESCO programme which is producing individual country profiles, in order to develop a Global Observatory of STI Policy Instruments (GO→SPIN), and, in parallel, to encourage the participating countries to produce an STI evidence-based policy analysis of their particular situation. The present study of Zimbabwe is one such profile.

The UNESCO project funded by Spain winds up in 2015. For the last phase, UNESCO is providing the Government of Zimbabwe with technical assistance in developing policy instruments to facilitate the commercialization of products and services generated as a spin-off from endogenous R&D. For instance, UNESCO is recommending the creation of an independent national agency which would administer one or more national funds promoting the commercialization of research results. The commercialization of research results is the third goal of Zimbabwe's *Second Science, Technology and Innovation Policy.*

Source: Juliana Chaves-Chaparro, UNESCO Associate Project Officer

First row, right to left: President of the Republic of Zimbabwe, H.E. Robert Gabriel Mugabe; Minister of Science and Technology Development, Hon. Heneri A. M. Dzinotyiweyi; Prime Minister of the Republic of Zimbabwe, Hon. Morgan R. Tsvangirayi and; UNESCO Science Specialist, Guy Broucke, at the launch of the *Second Science, Technology and Innovation Policy* on 13 June 2012 at the Harare International Conference Centre. Photo: UNESCO Harare Office

The SETI policy cycle in Zimbabwe

The term *policy cycle* refers to the recurrent pattern shown by procedures that ultimately lead to the creation of a public policy. The greatest advantage of the analytical model of the SETI policy cycle is that it facilitates an understanding of public policy-making by breaking down the complexity of the process into a limited number of stages and sub-stages, each of which can be investigated alone, or in terms of its relationship to any or all of the other stages of the cycle. This also allows for an examination of the role played by all actors and institutions dealing with SETI policies, rather than solely those governmental agencies formally charged with the task. The GO→SPIN methodological approach divides the SETI policy cycle into five different stages. Here are the working definitions provided for the survey:

I. **Agenda-setting:** refers to the process by which problems involving SETI and its relation to society and the economy come to the attention of the government. Agenda-setting is also a socially constructed process, in which actors and institutions, influenced by their respective ideologies, play a fundamental role in determining which problems or issues require government action (Howlett and Ramesh, 2003).

II. **Policy formulation:** refers to the process by which SETI policy options are formulated by the government. Policy formulation involves identifying and assessing possible solutions to policy problems, weighing the pros and cons, and deciding which should be accepted and which rejected. The relationship between the government and social actors thus exerts a significant influence on the formulation of public policies.

III. **Decision-making:** refers to the process by which governments adopt a particular course of action or non-action.

IV. **Policy implementation:** refers to the process by which governments put SETI policies into effect. This is when a decision is carried out through the application of government directives and is confronted with reality.

V. **Policy evaluation:** refers to the process by which the impact of SETI policies are monitored by both state and societal actors, the result of which may be a re-conceptualization of policy problems and solutions.

The SETI policy cycle has evolved at different stages of Zimbabwe's incipient history. Hove and Zinyama (2012) made a detailed analysis of the difficulties that the different social actors had to overcome in order to design the country's first S&T policy. In their conclusions, they stated that 'the findings disclosed that one of the chief institutional problems thereby delaying the formulation and finalization of the S&T policy was the fragmentation of the policy making process. There was absolutely no institutional coherence and integration. The S&T institutional arrangement evoked the slowness, the ponderousness and the complication of procedures for the national S&T development'. This description of the SETI policy cycle corresponds to UNESCO's own observations in March 2014, during the GO→SPIN survey validation process.

Figure 31: SETI policy cycle in Zimbabwe (c.2014). Source: UNESCO

THE SETI POLICY CYCLE IN ZIMBABWE

I. **Agenda-setting:** according to the Research Act, the research prioritization process should be performed by the Research Council of Zimbabwe, which has assigned a special committee to this task (see Box 15). The Research Council of Zimbabwe reports to the Office of the President and Cabinet. Each ministry also determines its own research and innovation priorities. The *Second Science, Technology and Innovation Policy* (2012) was proposed by the Ministry of Science and Technology Development, which was dissolved in 2013. Activities related to science and technology are the responsibility of the Department of Science and Technology Development within the new Ministry of Higher and Tertiary Education, Science and Technology Development. Since research and innovation are cross-cutting activities, other ministries have established lists of priorities within their own policies, including explicit references to scientific research, technological development and innovation. These ministries include: (a) Industry and Commerce; (b) Agriculture, Mechanisation and Irrigation Development; (c) Health and Child Care; (d) Environment, Water and Climate; (e) Energy and Power Development and; (f) Mines and Mining Development. At present, co-ordination among the different partners on SETI agenda-setting is weak.

II. **Policy formulation:** each individual organization (Research Council of Zimbabwe and the corresponding ministries listed above) currently uses its own priority-setting process to design and propose its own policy (i.e. see Republic of Zimbabwe, 2012a, 2012b; 2013a, 2013b and 2013c). The *Medium Term Plan* (Republic of Zimbabwe, 2011) and the *National Budget Statement* (Republic of Zimbabwe, 2013b) are working as co-ordinating schemes for the articulation of all the different policies.

III. **Decision-making:** upon completion of the policy formulation, the policy document has to be approved by the Cabinet and Parliament before it is launched and implemented.

IV. **Policy implementation:** according to the results obtained by the GO→SPIN survey, each individual policy adopted by the Cabinet and Parliament tends to be accompanied by the corresponding implementation plan, as in the case of the *Implementation Plan for the Second Science, Technology and Innovation Policy of Zimbabwe* (Republic of Zimbabwe, 2012c). These plans are usually designed by each individual ministry. The implementation plan usually includes lists of activities and performance indicators. The biggest shortcoming of these documents is the lack of any specific incentives and operational policy instruments to change the behaviour of the different SETI stakeholders. The absence of adequate co-ordination mechanisms for the different policies proposed by individual ministries also generates a lack of operational policy instruments connecting the SETI supply and demand sides (e.g. tax incentives to promote innovation in industry or incentives for the commercialization of new products generated with research labs).

V. **Policy evaluation:** several ministries in Zimbabwe are carrying out different types of SETI activity proposed explicitly within their corresponding policies. For the moment, policy evaluation is carried out by each individual ministry. A Cabinet Committee on Scientific Research, Technology Development and Application was proposed which would have had the mandate of proposing and assessing research and innovation projects implemented by different stakeholders but the committee never materialized (see page 91).

The analytical content of Zimbabwe´s SETI policy

The present section analyses the formal content of the *Second Science, Technology and Innovation Policy,* according to the methodological approach of the GO→SPIN survey, which has been designed to allow for international comparisons of the SETI policies adopted by different countries.

All the statements in the pages that follow have been reproduced from the official policy document (Republic of Zimbabwe, 2012a) but are organized hereafter according to the 14 standard fields proposed in the GO→SPIN survey. Some of these fields may be vacant, owing to the fact that the explicit policy does not take particular items into account.

BOX 11 – NATIONAL RESEARCH PRIORITIES OF ZIMBABWE

The Research Council of Zimbabwe was established in 1986 by an act of Parliament. Its mandate is to promote, direct, supervise and co-ordinate research. A major function is to advise the government on research priorities. The operational arms of the Research Council of Zimbabwe are its standing committees. At present, there are six committees namely: (1) National Research Prioritisation; (2) Research Control and Co-ordination; (3) Resource Mobilisation; (4) Research Promotion and Publicity; (5) Foreign Researchers and (6) Finance, Administration and Human Resources.

In 2011, the Government of Zimbabwe approved the National Research Priorities. The Research Council of Zimbabwe played a major role in setting these priorities. Financial and other resources are to be deliberately directed towards four priority areas:

The social sciences and humanities: understanding our role as a nation, what we want, need and where we want to be in the future, directing research to deliberately shape our future. The goals are to: (a) strengthen Zimbabwe social and economic fabric; (b) strengthen national policy-making processes; (c) understand our region and the world and; (d) intellectual property rights in Zimbabwe.

Sustainable environmental and resource management: improving the way we utilize our land, water, mineral and energy resources through a better understanding of human and environmental systems and the use of new production technologies, as well as aerospace and other sensing technologies. The goals are to: (a) bring together Zimbabwe's STI system; (b) transform agriculture; (c) add value to Zimbabwe's natural resources; (d) treat water as a critical resource (availability and utilization); (e) overcome land degradation; (f) foster sustainable use of Zimbabwe's ecosystems, including forests and biodiversity; (g) understand and develop deep earth resources; (h) respond to climate change and variability and; (i) develop sustainable energy resources.

Promoting and maintaining good health: promoting good health and well-being for all Zimbabweans. The goals are: (a) a healthy start to life: countering the impact of genetic, maternal, social and environmental factors which dispose infants to ill-health and reduce their well-being and life potential; (b) preventive health care; (c) greater access to health facilities and; (d) a revitalized national health delivery system.

National security of Zimbabwe: safeguarding Zimbabwe from terrorism, crime, invasive diseases and pests, strengthening our understanding of Zimbabwe's place in the region and the world, ensuring the proper exploitation of our natural resources and securing our infrastructure. The goals are to: (a) protect Zimbabwe from terrorism and crime; (b) protect Zimbabwe from invasive diseases and pests; (c) ensure a beneficial utilization of Zimbabwe's resources; (d) safeguard critical infrastructure and (e) use transformational defence technologies.

Source: Research Council of Zimbabwe

ANALYTICAL CONTENT OF THE *SECOND SCIENCE, TECHNOLOGY AND INNOVATION POLICY OF ZIMBABWE*[25]

I. **Policy vision:** to make science and technology an integral part of both individual and national development. This vision has been adopted in order to address the national challenge, namely, to accelerate development to a level closely comparable to that of the developed world in as short a time as possible. Such development has happened elsewhere through contributions from science and technology. Bearing that in mind, the challenge is therefore to develop innovative ways of bringing scientific and technological contributions to all developmental efforts done at both individual and national levels.

II. **Policy mission:** n/a

III. **Policy goals:** This STI policy has six primary goals which provide guidance for core activities that can be measured and programmed to take place over specified periods of time. Accordingly, under each of these primary goals, specific policies will be cited later (Republic of Zimbabwe, 2012b). The primary goals are to: (1) strengthen capacity development in STI; (2) learn and utilize emergent technologies to accelerate development; (3) accelerate commercialization of research results; (4) search for scientific solutions to global environmental challenges; (5) mobilize resources and popularize science and technology and (6) foster international collaboration in STI.

IV. **Policy objectives:** n/a

V. **Priorities at the strategic level of the SETI policy:** Specific policies are cited focusing on biotechnology, ICTs, space sciences, nanotechnology, indigenous knowledge systems and technologies yet to emerge:

1. *Biotechnology:* has relevance in fields such as agriculture, medicine and manufacturing, which can impact on the environment. Research and development need to be pursued in all these areas with the ultimate goal of enhancing positive outcomes in each of them while at the same time addressing safety concerns. Specific actions to be taken include: (a) promoting and co-ordinating biotechnology research on plants and animals aimed at increasing food productivity; (b) promoting the use of beneficial derivatives of biotechnology by farmers; (c) strengthening biotechnology research for disease prevention and control; (d) strengthening research aimed at optimizing manufacturing processes through the use of biotechnology and; (e) exploiting the biodiversity in the environment through biotechnology such as herbal products, fermentation processes and bio-leaching.
2. *Information and communication technologies (ICTs):* rapid advances have taken place through the use of ICTs and space sciences. Appropriate research is required to keep abreast with the rapid developments and make effective use of the knowledge available. This can be achieved through the following specific policies: (a) research into the creation of IT platforms for innovative deployment of data and knowledge for use in various sectors of the economy and; (b) enhancing national competence for computer hardware, software engineering and cyber security.
3. *Space sciences:* regionally and internationally, much attention is being paid to space sciences. This requires Zimbabwe to play its role in this area, as well. This can be achieved through the following specific policies: (a) carry out local R&D in space sciences, in order to enhance its wide diversity of applications, such as meteorology, land use, aeromagnetic surveillance and; (b) seek active participation in regional space science initiatives.

25 To facilitate international comparability, this section analyses the official document which refers explicitly to national SETI policies. Zimbabwe has produced other documents describing different policies related to research and innovation, including some related to SETI policy implementation (see, for example, Republic of Zimbabwe, 2012b). The most relevant complementary information is analysed in Boxes 11–14 within the present study.

BOX 12 – POLICIES DESIGNED TO WOO SKILLED EXPATS BACK HOME OR FOSTER NETWORKING

Zimbabwe's economic crisis over the past five years has precipitated a growing exodus of university students (see Table 19) and professionals from the country in search of better economic opportunities. Areas of expertise affected include medicine, engineering, surveying, architecture, audiology, veterinary medicine, forensic science and others. The loss of trained and experienced professionals is of growing concern, as it has negatively impacted on service delivery.

Initiatives aimed at addressing the loss of human skills have been initiated in Zimbabwe. One such initiative is the Taskforce on Human Skills Identification, Deployment and Retention, which was established by the Government of Zimbabwe following the adoption of the National Economic Development Priority Programme in 2004 with the purpose of addressing the loss of human skills from the country due to emigration.

In particular, the task force was set up to address brain drain and identify skills return and retention strategies that would facilitate an economic turn-around. In September 2006, a workshop was held in Nyanga on the theme of Strengthening National Capacities for Addressing Migration and Development in Zimbabwe; it was attended by senior government officials, academics, representatives from the private sector and the International Organization of Migration. At the workshop, a number of recommendations were proposed to address brain drain.

One recommendation gave top priority to establishing an interactive website and database to engage professionals in the diaspora in contributing to Zimbabwe's socio-economic development. In this regard, the government's Taskforce on Human Skills Identification, Deployment and Retention requested that the International Organization of Migration support the creation of this website endowed with a database of Zimbabwean professionals within and without the country.

Accordingly, the Zimbabwe Human Capital Website was created. One of its major purposes is to provide information on job opportunities in Zimbabwe, in order to link supply and demand. In addition, the website provides professionals in the diaspora with information on investment opportunities in Zimbabwe.

The majority of Zimbabweans in the diaspora have expressed their willingness to contribute to Zimbabwe's socio-economic development. With many professionals in Zimbabwe not deployed properly, partly because of the erosion of workers' real earnings, and with a new political landscape having been drawn by the government of national unity since 2009, there are now good prospects for professionals from both within and without Zimbabwe to participate in the national development effort.

Cognisant of the fact that the country's reconstruction will be hinged on a capable human resource base, it is imperative to familiarize interested stakeholders with the Zimbabwe Human Capital Website. These stakeholders include the Government of Zimbabwe, Public Service Commission, Zimbabwe National Chamber of Commerce, Confederation of Zimbabwe Industries, Zimbabwe Investment Authority, Employers' Confederation of Zimbabwe, National Economic Consultative Forum, Zimtrade, Zimbabwe Chamber of Mines, Zimbabwe Institute of Engineers, Teachers Associations, Health Services Board, Association of Employment Agencies, Association of Local Authorities, Research Council of Zimbabwe, Zimbabwe Academy of Sciences and the Commercial Farmers Union.

Source: adapted from: www.zimbabwehumancapital.org/about-zimbabwe-human-capital

4. *Nanotechnology:* is the application of processes and products at nanometre (10-9m) scale. Products from nanotechnology have been developed with significantly improved properties such as durability, efficiency and precision. It is an emergent technology that holds the power to revolutionize the way we approach fields such as agriculture, energy production and utilization, environmental protection, healthcare, information technology, national defence, among other fields. Nanotechnology can thus be exploited as an enabling engine for new economic growth, sustainable development and societal well-being. It has applications in all spheres of life. The following specific policies will help Zimbabwe to benefit from the advances in nanotechnology: (a) establish a national nanotechnology programme aimed at identifying and undertaking studies and research in aspects of nanotechnology for the benefit of the country (see Box 14); (b) develop a co-ordination framework for all activities related to nanotechnology undertaken by local institutions and; (c) develop regulations and standards in keeping with international developments in nanotechnology that are beneficial for the country to uphold.
5. *Indigenous knowledge systems (IKS):* Traditionally, IKS has played an important role in daily life and development in Zimbabwe. Aspects such as the value of indigenous fruits, animal breeding, soil cultivation, herbal medicines, etc., have been well known and applied and are gradually phasing out of living memory in various localities. Many of these traditions and products can still play an important role in the future development of Zimbabwe, particularly in the rural areas. Researching relevant IKS for current and future needs would help complement other existing and emerging technologies. The following specific policies will help Zimbabwe to benefit from IKS: (a) develop a database on IKS with a view to identifying aspects that can be exploited using modern science and technology (e.g. synthetic biology) for national benefit; (b) promote research on potential applications of IKS to tackle future national developmental challenges and; (c) develop courses on IKS that are suitable for inclusion in the school curricula.
6. *Technologies yet to emerge:* it is necessary to provide for the adoption and adaptation of new technologies, as and when appropriate: (a) high-level technologies that are yet to emerge and are deemed relevant to the needs of Zimbabwe will need to be adopted in a related manner with the appropriate risk assessment.
7. *Scientific solutions to emergent environmental challenges:* (a) research aimed at finding appropriate flora and fauna able to thrive under changing climatic conditions, such as drought-tolerant and disease- resistant crops and animals, crops with short growing seasons, etc.; (b) promote use of earth observation technologies to improve national capability in early warning and forecasting of changes and compliance with international requirements; (c) continually search for appropriate materials for effective management, mitigation and control of environmental challenges; this should give due consideration to matters relating to ecology, pollution, water and alternative sources of renewable energy e.g. bio-fuels, wind energy as well as solar, and; (d) maintain the national gene bank so as to preserve the national gene stock.

VI. **Normative planning strategies of the policy:** the government is committed to (a) making a budgetary allocation of at least 1% of GDP for expenditure on R&D and (b) focusing at least 60% of university education on S&T skills development.

VII. **Policies related to the supply of SETI:**

1. *Education:* the goal is to compliment efforts by the education sector ministries, as follows: (a) pupils at primary and secondary school should spend at least 30% of their overall time studying science subjects; this translates into a requirement for every O' level secondary student to study mathematics and at least two other science subjects, as mathematics is already a compulsory subject of study; (b) practical experiments should exploit the background experiences of students and encourage interest across gender; (c) science subjects must be taught in a manner that allows each pupil to undertake direct practical experimentation regularly and; (d) teachers and students should regularly use the internet to learn and evaluate the scientific topics that are taught, as well as successful approaches used in other countries.

2. *Skills development:* (a) all employers in the socio-economic production and services sector are to expose their employees to the technical basis of their work; (b) develop and monitor the level of research and S&T skills available in the country; (c) encourage interdisciplinary research and technological engagements to address national challenges through S&T; (d) every science teacher should hold a minimum qualification of a relevant degree in the subject taught and; (e) science teachers, technicians and professionals should continually improve their skills.
3. *Institutions and infrastructure development:* (a) functional science laboratories must be in place and maintained in all schools, universities and related research and training institutions; (b) modern technological developments such as ICT should be readily available to institutions to ensure competitiveness; (c) promote the development of centres of excellence in various disciplines of S&T at tertiary and research institutional levels and; (d) promote institutional linkages and regularly review their collaborative networks in order to avoid duplication of efforts and achieve optimal usage of resources.
4. *Funding:* the government is committed to (a) making a budgetary allocation of at least 1% of GDP to expenditure on R&D; (b) developing adequate mechanisms for channelling all government or budgetary allocations for R&D through one dedicated institution; (c) putting in place tax concessions for companies that channel funds and donations towards R&D; (d) giving awards/ incentives and recognition for achievements in S&T and; (e) mobilizing funds for engaging in international collaborative research.

VIII. **Policies related to demand for SETI:** (a) incentivize the uptake of new operations based on new research findings; this could include the provision of space in technoparks, seed funding and tax exemptions; (b) strengthen the national intellectual property rights regime, in particular, and promote and facilitate the registration of patents from institutions, researchers and inventors and; (c) promote the establishment of funds dedicated to the commercialization of research results and output by various relevant institutions; this section suggests establishing funding schemes based on the model of the existing Innovation and Commercialisation Fund (see page 91).

IX. **Policies to foster networking between the SETI supply and demand sides:** (a) forge linkages between tertiary institutions and industry dedicated to harnessing research results for commercialization; (b) establish science and technology parks at research institutions and universities; this may include parks that service multiple institutions and independent innovators, and; (c) popularize S&T in a manner that reaches out to the majority of the population.

X. **Regional and international dimensions of SETI policies:** (a) call on tertiary institutions to engage in relations geared towards collaborative research between research institutes nationally, regionally and internationally; (b) national R&D institutions and researchers should actively pursue membership of distinguished international bodies; (c) Zimbabwe shall join and maintain good standing membership of distinguished international bodies; (d) the government shall enter into mutually beneficial partnerships or agreements with other countries and multilateral organizations and accede to S&T protocols in order to benefit the nation; (e) create linkage platforms that can facilitate engagement by scholars and researchers abroad (including those in the diaspora) with local STI activities and (f) create and promote platforms for technology screening, transfer, acquisition, adoption and absorption.

XI. **Monitoring, assessment, technological forecasting and prospective scenarios:** (a) identify and document national and global research results/output and technologies that can enhance value addition to national resources.

XII. **SETI policy start date:** 2012

XIII. **Timespan for SETI policy planning:** 2012 onwards (open)

XIV. **Link:** www.healthresearchweb.org/files/Zimbawesciencetechpolicydocumentnew.pdf

BOX 13 – ZIMBABWE'S NATIONAL BIOTECHNOLOGY POLICY

The 2005 Zimbabwean *National Biotechnology Policy* seeks to ensure the safe and judicious use of biotechnology, with a view to maximizing its potential benefits while minimizing any adverse effects on health (human and animal) and the environment.

The role of modern biotechnology in the economic and sustainable development of Africa is becoming a focus as a result of several factors, including recent famines and hunger in the sub-Saharan region, increased commercialization of genetically modified crops and foods, and rapid scientific and technological advances.

Faced with a wide range of societal, scientific, ethical, health, environmental, trade and economic issues associated with modern biotechnology research and development and its applications in Africa, many African governments have adopted responses which betray uncertainty and confusion. The issue of biotechnology research, development and implementation is thus closely tied to the elaboration of regulations to monitor and guide this research and its products.

A well-functioning regulatory system can instil confidence in the public that the risk assessment used to evaluate biotechnologies is science-based, as stated under Article 15 and in Annex III of the *Cartagena Protocol on Biosafety*. Zimbabwe is a signatory to this protocol, itself an addendum to the Convention on Biological Diversity. Zimbabwe has developed a legal framework to guide research and development of modern biotechnology through its National Biotechnology Authority Act (Act 3, 2006/ Chapter 14:31).

Zimbabwe has legal mechanisms in place to ensure the safe and effective development and application of biotechnology. In 2006, the National Biotechnology Authority was established through an act of Parliament with a broad mandate to oversee the conduct of biotechnology research, development and its field application in Zimbabwe. The authority also has a mandate to advise the Minister of Higher and Tertiary Education, Science and Technology Development on all aspects of the development, production, use, application and release of products of biotechnology.

The first and most relevant initiative for promoting human development in biotechnology was the establishment of the Masters of Science Degree in Biotechnology at the University of Zimbabwe in 1991. Close to 80 MSc in Biotechnology students have graduated from the programme, the majority of whom have gone on to obtain PhD degrees locally and abroad. A number of local universities now have undergraduate degree programmes in biotechnology. The National University of Science and Technology also runs an MSc programme in Applied Microbiology and Biotechnology. The Scientific and Industrial Research and Development Centre has set up the Biotechnology Research Institute. There is also a very active biotechnology research group.

However, according to Parawira and Khosa (2009), Zimbabwe needs to develop a national biotechnology strategy that outlines a clear vision, research priorities, commitment and various pathways to biotechnology research and development and human resource development. This strategy should define how all biotechnology sectors (medical, agricultural, food and industrial and environmental sectors) are going to be developed and fitted into overall national development goals.' These authors considered that there was a need to set research priorities among different biotechnology stakeholders and to integrate research efforts with the broader objectives of national development, in order to improve the interaction among biotechnologists and farmers, the industrial sector, the broader scientific community and policy-makers.

Current projects in agricultural biotechnology are mainly carried out at universities and public research institutes with a focus on plant propagation and improving resistance to disease, herbicides, drought and insects. Plant tissue culture especially is widely used while a few laboratories are engaged in genetic engineering. In food and beverages, biotechnology research focuses on microbiology and biochemical processes, as well as the use of starter cultures during fermentation of traditional foods. Zimbabwe's involvement in industrial biotechnology is limited to the search for, and use of, the country's biological resources as sources of potential industrial enzymes. Biotechnology research of environmental relevance includes the decoloration of textile dyes, wastewater treatment and biogas production from municipal, industrial and agricultural waste (water).

Zimbabwe's biotechnology is mainly traditional, with most research organizations applying less advanced biotechnology techniques. Poor infrastructure and a lack of both human resources and funding are the major challenges, although biotechnology research, development and management are better established in Zimbabwe than in most sub-Saharan African countries.

Biotechnology features in the *Second Science, Technology and Innovation Policy* (Republic of Zimbabwe, 2012a), under the second primary goal of learning and utilizing emergent technologies to accelerate development. The policy advocates: (a) promoting and co-ordinating biotechnology research on plants and animals aimed at increasing food productivity; (b) promoting the use of beneficial derivatives of biotechnology by farmers; (c) strengthening biotechnology research for disease prevention and control; (d) strengthening research aimed at optimizing manufacturing processes through the use of biotechnology and; (e) exploiting the biodiversity in the environment through biotechnology such as herbal products, fermentation processes and bio-leaching.

BOX 14 – ZIMBABWE'S NATIONAL NANOTECHNOLOGY PROGRAMME

Under the second primary goal of learning and utilizing emergent technologies to accelerate development, *the Second Science, Technology and Innovation Policy* (Republic of Zimbabwe, 2012a) made provisions for establishing a National Nanotechnology Programme. The policy states that this programme is to identify and undertake studies and research in aspects of nanotechnology for the benefit of the country. It is to co-ordinate the development of a national nanotechnology policy and implementation programme and to facilitate the establishment of a national nanotechnology council and directorate. It is also to commission a survey to identify the sectors/centres of excellent that could take advantage of nanotechnology. The policy also calls for a national nanotechnology strategy with priority areas to be developed, as well as regulations and standards that are in keeping with international developments in nanotechnology.

The programme is run by the National Nanotechnology Coordinating Committee appointed by the former Minister of Science, Technology and Development. The committee is comprised of an intersectorial stakeholder expert team drawn from government, development agencies, industry and academia and is managed by a senior officer and staff from the ministry serving as the programme secretariat. The specific functions of the committee are to: (1) supervise and control the research, development and utilization of nanomaterial and nanotechnology; (2) register and maintain a list of all institutions and individuals who engage in research, development and utilization of nanomaterial and nanotechnology within Zimbabwe; (3) promote and support education and foster research into the development and utilization of nanomaterial and nanotechnology and; (4) report, in an advisory capacity, to the minister responsible for science and technology development on all issues regarding nanomaterial and nanotechnology.

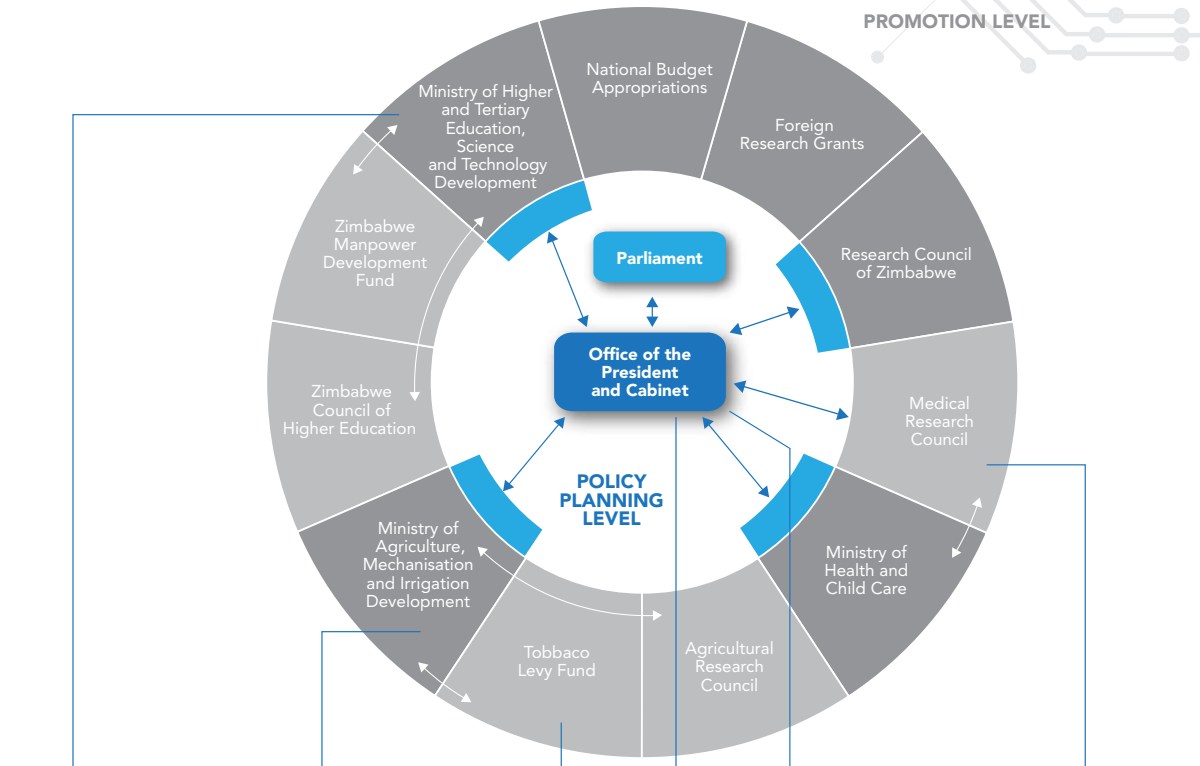
The National Nanotechnology Programme will address the following issues: (a) promote education and training in nanotechnology within national educational curricula; (b) strengthen research and innovation in nanotechnology within Zimbabwean universities and research institutions; (c) enhance local and international collaboration among stakeholders involved in nanotechnology; (d) promote commercialization and industrialization through the application of nanotechnology in areas such as water purification, energy generation, drug production, textile production, mineral beneficiation and electronics and; (e) promote health through the early identification of diseases.

In line with the vision and mission of the *2012 Second Science, Technology and Innovation Policy,* the National Nanotechnology Programme seeks to: (i) be a world-class resource for the realization of innovation and commercialization processes utilizing nanotechnology for the economic growth and social advancement of Zimbabwe and for the benefit of humanity as a whole; (ii) provide regulatory and policy frameworks for monitoring and supervising training, research, development and innovation in nanotechnology and nano-based materials; (iii) enable the development of nanotechnology systems for biomedical, energy, environmental, information technology and other applications through innovative multidisciplinary research and educational programmes and; (iv) provide solutions which contribute to social well-being and national economic growth through the translation of research results into innovative practice to commercial technological applications (Republic of Zimbabwe, 2012d).

Analysis of the SETI organizational chart and flows in Zimbabwe

The SETI organizational chart shows the distribution of responsibility for implementing a given policy. Under the term 'organizational chart', we may distinguish at least four different levels: (1) policy-planning level (policy design); (2) promotional level (funding); (3) implementation level (scientific research, technological development and productive innovation); (4) scientific and technological services and; (5) assessment or evaluation level.

The chart on the facing page shows the characteristics of the national research and innovation system in Zimbabwe. The fifth level (assessment or evaluation) is missing for Zimbabwe.



PERFORMANCE LEVEL

Universities

- Africa University
- Bindura University of Science Education
- Chinhoyi University of Technology
- Great Zimbabwe University
- Gwanda State University
- Harare Institute of Technology
  - Technopreneurship Development Centre
  - Teaching and Learning Centre
  - Technology Centre
  - Business Units
- Lupane State University
- Midlands State University
- National University of Science and Technology
- University of Zimbabwe
  - University Lake Kariba Research Station
  - Development Technology Centre
  - Institute of Environmental Studies
  - Institute of Mining Research
  - University of Zimbabwe School of Technology
- Women's University in Africa
- Zimbabwe Open University
- Agricultural Colleges

Ministry of Agriculture, Mechanisation and Irrigation Development

- Agricultural Research Council
- Grain Marketing Board
- Department of Research and Specialist Services
- Coffee Research Station
- Cotton Research Station
- Crop Breeding Institute
- Grasslands Research Station
- Henderson Research Station
- Makholi Experiment Station
- National Veterinary Laboratory
- Tobacco Research Board/Kutsaga Research Station
- Matopos Agricultural Research Centre

Tobbaco Research Board

Scientific and Industrial Research and Development Centre (SIRDC)

- Biotechnology Research Institute (BRI)
- Building Technology Institute (BTI)
- Electronics and Communications Institute (ECI)
- Energy Technology Institute (ETI)
- Environmental Sciences Institute (ESI)
- Food and Biomedical Technology Institute (FBTI)
- Geo-Informatics and Remote Sensing Institute (GRSI)
- Informatics Institute (II)
- Metallurgical Research Institute (MRI)
- National Metrology Institute (NMI)

Ministry of Health and Child Care

- Medicine Control Authority of Zimbabwe
- Medical Research Council of Zimbabwe
- National Aids Council of Zimbabwe
- National Institute for Health Research
- Hospitals

SCIENTIFIC AND TECHNOLOGICAL SERVICES LEVEL

Ministry of Energy and Power Development

- Zimbabwe Electricity Supply Authority
- Zimbabwe Energy Regulatory Authority
- Rural Electrification Agency

Ministry of Environment, Water and Climate

- Meteorological Service Department
- Zimbabwe Parks and Wildlife Management Authority
- Environmental Management Agency
- Zimbabwe Nation Water Authority

Ministry of Finance and Economic Development

- Industrial Development Corporation of Zimbabwe
- Zimbabwe Economic Policy Research Analysis Unit
- Zimbabwe National Statistics Agency
- Zimbabwe Revenue Authority

Ministry of Justice, Legal and Parliamentary Affairs

- Patent Office

Ministry of Mines and Mining Development

- Chamber of Mines
- Minerals Marketing Corporation of Zimbabwe
- Zimbabwe Geological Survey Department

National Biotechnology Authority

Figure 32: Organizational chart showing Zimbabwe's research and innovation system

Inventory of SETI Institutions in Zimbabwe

SETI GOVERNING BODIES IN ZIMBABWE

RESEARCH COUNCIL OF ZIMBABWE

Address: 11 Stafford Road, Mount Pleasant, Harare, Zimbabwe

Telephone: (+263) 4-304708/304787/304733

Website: www.rcz.ac.zw

Executive head: Mrs Susan Muzite

Established: 1986 by the Research Act

Aims and Responsibilities: to be the pivotal leader, guiding all research towards the sustainable development of Zimbabwe and to provide leadership in research for national development. The Research Council of Zimbabwe guides, co-ordinates and promotes research. It publishes research and reports and holds symposia on priority national development challenges. It maintains a referral database of all national research activities for stakeholders and promotes a good and effective relationship with all stakeholders (see Box 15 overleaf).

Priority level of the following functions:

1. Planning/programming/budgeting of SETI activities: *high priority*
2. Promotion/financing/co-ordination of SETI activities: *high priority*
3. Application/transfer/assessment of SETI activities: *high priority*
4. Advocacy of SETI activities: *high priority*
5. General policy advice: *high priority*

Network of relationships in the country: upstream linkage

Administrative entity specifically in charge of exchange of information with foreign organizations: *Executive Director*

Preferred language: *English*

Frequency of professional contacts with the following organizations:

1. Organizations of the United Nations system: *regular professional contacts*
2. Other intergovernmental organizations: *regular professional contacts*
3. International non-governmental organizations: *irregular professional contacts*
4. National SETI policy bodies in foreign countries: *irregular professional contacts*
5. Other institutions in foreign countries dealing with SETI policy studies: *regular professional contacts*

SETI policy-related publications of the organization:

i. Zimbabwe Research Index (annually)

ii. Directory of Research Institutes and Professional Associations (triennially)

iii. Proceedings of international symposia held in Zimbabwe (see Box 17, page 180)

Number of professional staff and gender distribution: *n/a*

Annual budget: *n/a*

Ministry of Higher and Tertiary Education, Science and Technology Development

DEPARTMENT OF SCIENCE AND TECHNOLOGY

Address: Room F721, 6th Floor, Government Composite Block Corner Samora Machel and Fourth Street P.O. Cy 7732 Causeway, Harare, Zimbabwe

Telephone: (+263) -4-705531/796441-9

Website: n/a

Executive head: Dr Washington T. Mbizvo

Email: wtmbizvo@yahoo.co.uk

Established: 2013 (after the former Ministry of Science and Technology Development was dissolved)

Aims and Responsibilities: the Department of Science and Technology is mandated to provide leadership in research, science, technology and innovation in Zimbabwe through the provision of an enabling environment in terms of policy and legislation, combined with co-ordination and monitoring.

Priority level of the following functions:

1. Planning/programming/budgeting of SETI activities: highest priority
2. Promotion/financing/co-ordination of SETI activities: highest priority
3. Application/transfer/assessment of SETI activities: highest priority
4. Advocacy of SETI activities: highest priority
5. General policy advice: *highest priority*

Network of relationships in the country: upstream linkage

Administrative entity specifically in charge of exchange of information with foreign organizations: *Directorate of Science and Technology Unit*

Preferred language: *English*

Frequency of professional contacts with the following organizations:

1. Organizations of the United Nations system: *regular professional contacts*
2. Other intergovernmental organizations: *regular professional contacts*
3. International non-governmental organizations: *irregular professional contacts*
4. National SETI policy bodies in foreign countries: *regular professional contacts*
5. Other institutions in foreign countries dealing with SETI policy studies: *regular professional contacts*

SETI policy-related publications of the organization:

Second Science, Technology and Innovation Policy (March, 2012)

Implementation Plan for the Second Science, Technology and Innovation Policy of Zimbabwe (June 2012)

(These publications were produced by the former Minister of Science and Technology Development.)

Number of professional staff and gender distribution: *n/a*

Annual budget: *n/a*

BOX 15 – RESEARCH COUNCIL OF ZIMBABWE

The Research Council of Zimbabwe was established by the terms of the 1986 Research Act. It succeeded the Scientific Liaison Office set up in the Prime Minister's Office in 1967.

The Research Council of Zimbabwe is mandated to promote, direct, supervise and co-ordinate research for sustainable development. Its mission is multifaceted: to guide, co-ordinate and promote research; to strive for a high number of quality research publications, reports and symposia which aim to solve priority national development challenges; to maintain a referral database of all national research for stakeholders; to promote a good, effective relationship with all stakeholders and; to provide the secretariat with a safe, challenging, professional and rewarding work experience.

One major function of the Research Council of Zimbabwe is to advise the government on issues related to research for sustainable development. The council also provides an exceptional forum for interaction and discussion for the mutual benefit of government, academia and industrialists. It is an established conduit for financial and administrative support for collaborative research among research institutes and councils. The Research Council of Zimbabwe organizes international symposia and produces the proceedings thereof (see Box 17). Under the council's grants and awards programme, six journals have received funding.

The Research Council of Zimbabwe plays the role of catalyst. Once having identified broad areas of concern, it consults and brings together relevant experts to define a programme of work and see funding sources. The council establishes and maintains links with professional bodies and centres of excellence to enhance the quality of its role as a facilitator of national and international collaboration. Collaborative linkages with organizations such as The World Academy of Sciences for the Advancement of Science in Developing Countries (TWAS), International Council for Science (ICSU) and its regional office for Africa, as well as with United Nations programmes, keep the council abreast of international developments.

Research Council of Zimbabwe's standing committees

National research prioritisation and strategic planning committee: advises the council on national research policy and recommends the creation of new research councils; recommends national research priorities, identified by applying an agreed framework and methodology; recommends and instigates periodic reviews of national priorities, considers research programmes of research councils and research institutes requiring policy direction and makes recommendations.

Research control and co-ordination committee: considers cases of unethical conduct on behalf of the council; develops and updates research fund disbursement policies, guidelines, regulations and related instruments for consideration by the council; disburses research funds on behalf of the council; conducts training of users and provides guidelines; considers reports on research; conducts research audits ensuring that persons, animals, plants and the environment in general are protected from the effects of potential harmful research or undertakings.

Research promotion, publicity and resource mobilisation committee: fosters the publication of refereed journals, including e-journals; oversees the updating and maintenance of the Research Council of Zimbabwe's website; makes recommendations on grants to be made by the council;

organizes research symposia, conferences, workshops, seminars and related activities; makes recommendations on donations to be made and fellowships to be awarded by the council; mobilizes resources for the Research Council of Zimbabwe; develops funding mechanisms for the national research agenda and make recommendations to the council, raises funds for the budget in line with the approved funding mechanism.

Foreign researchers committee: assesses proposals and, where appropriate, issues permits to foreign scholars; monitors progress by foreign researchers, advises the council on how best to benefit from the research done by foreigners; advises the council on improving the monitoring of foreign researchers; liaises with affiliated institutions on ways to improve the administration of applications by foreign researchers.

Finance, administration and human resources committee: ensures that the organization is running smoothly, reviews financial statements and quarterly management accounts before submission to the council; considers budgets before and after submission to the Ministry of Finance, makes recommendations to the council on the appointment of external auditors; considers human resource issues and makes recommendations to the council as appropriate.

Achievements of the Research Council of Zimbabwe

(a) Institutions established: according to Section 16 (g) (iii) of the Research Act, one of the mandates of the Research Council of Zimbabwe is to establish research councils or research institutes to conduct research. Since its inception, it has facilitated the establishment of the following institutions: Scientific and Industrial Research Development Centre (est. 1993); Zimbabwe Academic Research Network (est. 1997), Bio-Safety Board (est. 2000). It has also catalysed and facilitated the creation of the Zimbabwe Academy of Sciences (est. 2004; see page 134).

(b) Organization of symposia on science and technology: symposia are run by the Research Council of Zimbabwe to bring together researchers, policy-makers and industrialists from within and beyond Zimbabwe. Local and regional researchers present research results and forge linkages with users of such results. The Research Council of Zimbabwe has held nine symposia to date (see Box 17).

(c) Other achievements: (a) it organized, in 2004, the first Regional Meeting for Africa on behalf of the International Council for Science (ICSU), of which it has been a member since 1989; (b) it organized the launch of the *National Science and Technology Policy* in 2002; (c) it has supported the publication of six journals; (d) it is a member of the National Economic Consultative Forum and National Council for Higher Education; (e) it represented Zimbabwe in the following international fora: World Solar Summit (1996), Harare; World Conference on Science (1999), Budapest, Hungary; United Nations Regional Preparatory Conference for Exploration and Peaceful Uses of Outer Space; Global International Smart Partnership Dialogue; African Caribbean and Pacific Group of States Forum on Research and Sustainable Development; Third World Network of Scientific Organisations (TWNSO); World Summit on Sustainable Development (2002), Johannesburg, South Africa; World Summit on Information Society (2003), Tunis, Tunisia.

Source: www.rcz.ac.zw/

NATIONAL BIOTECHNOLOGY AUTHORITY (FORMERLY BIOSAFETY BOARD)

Address: 21 Princess Drive, Newlands, Harare, Zimbabwe

Telephone: (+263) – 4- 782856/9

Website: www.nba.ac.zw

Executive head: Dr Jonathan Mufandaedza

Email: jmufandedza@gmail.com / nba@nba.ac.zw

Established: in 1998, the Government of Zimbabwe amended the Research Act to provide for the management of potentially harmful technologies and undertakings which involved biotechnology. In 2000, the Research (Biosafety) Regulations were gazetted and the Biosafety Board was established. The National Biotechnology Authority Act of 2006 [Chap. 14:31] created the National Biotechnology Authority, which replaced the Biosafety Board.

Aims and Responsibilities: The mandate of the National Biotechnology Authority is to support and manage biotechnology, research, development and application in the following priority areas: agriculture, health, environment, industry and energy. The National Biotechnology Authority ensures biosafety and biosecurity in the development and deployment of biotechnology. Additionally, it advises the government on all aspects of the development, production, use, application and release of the products of biotechnology and ensures that such activities are done in accordance with the provisions of the National Biotechnology Authority Act of 2006 [Chap.14.31]. The key operational arms of the National Biotechnology Authority are: (1) regulatory affairs; (2) R&D and; (3) public awareness and education.

Priority level of the following functions:

1. Planning/programming/budgeting of SETI activities: *highest priority*
2. Promotion/financing/co-ordination of SETI activities: *high priority*
3. Application/transfer/assessment of SETI activities: *high priority*
4. Advocacy of SETI activities: *high priority*
5. General policy advice: *high priority*

Network of relationships in the country: downstream linkage

Administrative entity specifically in charge of exchange of information with foreign organizations: *n/a*

Preferred language: *English*

Frequency of professional contacts with the following organizations:

1. Organizations of the United Nations system: *regular professional contacts*
2. Other intergovernmental organizations: *regular professional contacts*
3. International non-governmental organizations: *irregular professional contacts*
4. National SETI policy bodies in foreign countries: *irregular professional contacts*
5. Other institutions in foreign countries dealing with SETI policy studies: *irregular professional contacts*

SETI policy-related publications of the organization:

National Biotechnology Policy, 2005

National Biotechnology Authority Act, 2006, [Chap. 14.31]

Number of professional staff and gender distribution: *n/a*

Annual budget: *n/a*

INVENTORY OF GOVERNMENT INSTITUTIONS RELATED TO R&D, INNOVATION AND S&T SERVICES

SCIENTIFIC AND INDUSTRIAL RESEARCH AND DEVELOPMENT CENTRE (SIRDC)

Address: 1574 Alpes Road, Hatcliffe, Harare, Zimbabwe.

Executive head: Dr Robson Mafoti

Telephone: +263 4 860321-9

Website: www.sirdc.az.sw

In a bid to improve Zimbabwe's competence in SETI, the government established the Scientific and Industrial Research and Development Centre (SIRDC) in February 1993, under the provisions of the Research Act of 1986.

The centre has the following mandate: (1) to carry out strategic R&D for the benefit of the industrial, service, agricultural, health and mining sectors of Zimbabwe; (2) to collaborate with other local and international institutions and universities in strengthening local R&D capacity and its application to industrial processes; (3) to adapt imported technology to local needs; (4) to provide consultancy services to local and regional enterprises; (5) to promote technological partnerships and a quality culture in business and; (6) to serve as a repository and disseminator of information on technology.

The institutional vision is for SIRDC to become the leading centre for the development of Zimbabwe and the region, through reduction to practice of technologically developed products and processes. The mission statement proposes providing Zimbabwe and the region with technological solutions for sustainable development. The core values are to: uphold integrity in all activities in which the centre is involved; be an equal opportunity employer; comply with government policies and regulations; recognize the value of its employees; encourage team work; be a learning organization; recognize ethical business relationships and; value safety, health and the environment. The broad strategy is to produce high-value, high-quality, competitive products and services.

SIRDC thus focuses on: (a) technology generation; (b) technology upgrading; (c) technology adaptation; (d) innovation; (5) unpacking technology, as well as; (6) technology transfer.

SIRDC has commercialized some of its products through Sirtech Investments (Pvt) Ltd.

It is important for SIRDC to retain skills, if it is to provide industry with continual support. Like other advanced educational and training institutions, SIRDC experienced a rash of resignations by directors, senior researchers, other researchers and technicians in 2008.

Nine of the 11 SIRDC institutes deal directly with the engineering sector but all are relevant to industry. SIRDC also provides a service to various ministries.

In addition to its 11 specialized institutes, SIRDC also has the following complementary departments: Business Operations, Finance, Farming Operations, Human Resources, Purchasing, Transport, Audit, Cafeteria, Works and Physical Planning, and Public Relations. In addition, SIRDC administers the Food and Nutrition Council and the Technological and Commercial Information Promotion System.

The 11 specialized institutes comprising SIRDC[26] are:

- **Biotechnology Research Institute (BRI):** a centre of excellence in the application of biotechnological techniques and processes to enhance performance in agriculture, medicine and bioprocessing industries. The institute draws its strength from an intimate knowledge of genetics, microbiology, cell biology, molecular biology, biochemistry, animal cell culture, embryology and chemical/process engineering. The institute has world-class expertise in manipulating living organisms and bioprocesses to improve plant varieties and animal breeds, enhance health delivery processes, and facilitate the production of biological molecules through cell culture and fermentation technology processes. The main objectives are to: (a) conduct research into plant and animal genetics, with a view to producing animal/crop varieties that will boost agricultural production; (b) develop crop varieties suited for growth in marginal zones for the benefit of rural and small-scale farmers and to ensure food security; (c) carry out research in disease diagnostics and health delivery processes; (d) provide technical expertise in the collection, identification and conservation of valuable germplasm; (e) adapt biotechnology to the needs of agriculture, horticulture and industry; (f) provide advisory services to the government and the private sector on genetically modified organisms and; (g) participate in, and provide advisory services, in the area of biodiversity and biosafety.

- **Building Technology Institute (BTI):** the focal point for R&D activities in building science and technology, as well as technology transfer and consultancy services in the areas of design, building materials, housing, planning, construction engineering and related activities. BTI encompasses the whole technology spectrum for the built environment. The institute's primary goal focuses on the development and strengthening of capacity and capability through R&D in the following core areas: (a) physical infrastructure creation, maintenance and refurbishment; (b) provision of cost-effective technology-based solutions for the building industry; (c) devising innovative shelter delivery strategies and mechanisms; (d) provision of technical information and advisory services on the built environment and; (e) training in the construction field.

- **Electronics and Communications Institute (ECI):** established to carry out R&D in the two rapidly advancing fields of electronics and communications and to provide consultancy and industrial support services to the local manufacturing and technology industries. It is involved in the design and development of world-class original products as part of import substitution. Electronics can be applied effectively in the following economic sectors: agriculture, mining, manufacturing, services (e.g. telecommunications). ECI aims to be the leader in the design and development of products and solutions for the electronics and communications industry in Zimbabwe and the region.

- **Energy Technology Institute (ETI):** provides technological solutions and services in the energy field to public and private institutions in Zimbabwe. ETI strives to establish and maintain close and permanent partnerships with industry and all stakeholders in areas of mutual benefit related to collaborative research, the development of new products, provision of expert technical services and training in the energy field. ETI collaborates with power supply utilities, providers of industrial and domestic consumer services, the government, non-governmental organizations and energy research and development organizations in and beyond Zimbabwe. The institute's mandate determines the need for: (a) spearheading technology development within the energy sector; (b) adapting, upgrading and transferring energy technologies for the benefit of industry in Zimbabwe; (c) promoting efficient use of energy resources; (d) maximizing energy availability, accessibility and affordability; (e) spearheading the introduction of environmentally friendly energy resources to the local market; (f) providing information on energy technology to various stakeholders; (g) building technical capacity and developing a human resource base with technical expertise in the energy sector; (h) establishing state-of-the-art energy management systems; (i) ascertaining the energy needs of Zimbabwe and providing technical solutions.

- **Environmental Sciences Institute (ESI):** a national institute set up to provide technological services to national and regional stakeholders in order to enhance the environmental performance of industrial products and services in local and international markets. ESI has established an enduring partnership

26 At the time of preparation of this GO→SPIN country profile, the Polymer Sciences Institute was in gestation.

with industry and other stakeholders through collaborative research, the development of new products, consultancy and training in the environmental field. It also hosts the National Cleaner Production Centre of Zimbabwe. ESI's objectives are to: (a) develop and apply technologies and methods and/or products for solving environmental challenges in a sustainable manner; (b) conduct research on, and contribute to, sustainable natural resource management and protection of natural resources and the environment; (c) provide technical assistance in environmental management and cleaner production services and conduct environmental impact assessments for development projects; (d) provide technical consultancy and advisory services in environmental education, management and climate change and; (e) participate in national, regional and international collaborative research.

- **Food and Biomedical Technology Institute (FBTI):** carries out R&D in food technology, industrial biotechnology and applied chemistry. FBTI's objectives are to: (a) develop and reduce to practice technologies and processes that will lead to the setting-up of industries in the food, pharmaceutical and biochemical sectors; (b) adopt and adapt new technologies in the food and biomedical industries; (c) provide technical consultancy and training services to industries in the food, chemical, biochemical and pharmaceutical sectors; and (d) conduct research for, and provide analytical services to, the food, chemical, pharmaceutical and biomedical industries.

- **Geo-Informatics and Remote Sensing Institute (GRSI):** contributes to the achievement of sustainable environmental resource utilization in Zimbabwe and the region. The objective of GRSI is to provide spatial data analysis solutions to make environmental and natural resources management more sustainable than would otherwise be possible without this technology. GRSI has the capacity to design and develop products that embrace the spatial dimension for informed decision-making in: (a) natural resources management; (b) Earth and water resources management and; (c) land administration and facility management.

- **Informatics Institute (II):** utilizes systematic procedures to provide highly scalable bespoke software engineering systems for the processing, management and retrieval of digital information, in order to simplify the decision-making process. The institute focuses on manufacturing systems, database systems, artificial intelligence systems, multimedia, e-commerce and Internet programming. Its aims to design software engineering systems that deliver the right information to the right user in the right place and at the right time and in the right way for decision-making. The main objective is to spearhead the adoption and promotion of computer-based information systems as a tool for economic development.

- **Metallurgical Research Institute (MRI):** undertakes R&D in mining, metallurgical, materials, foundry and other forming technologies, and develops and commercializes a portfolio of bankable projects in the specialized area of metallurgy. The goals of the institute are to: (a) provide technical consultancy and training services to the mining and metallurgical industries; (b) provide assay and analytical services for base, minor, platinum group metals and precious metals, ferro-alloys, coals and metallurgically complex (refractory) ores and concentrates; (c) pre-feasibility and due diligence studies in mineral and extractive metallurgy projects; (d) conduct metallurgical accounting, process audits, trouble-shooting and optimization of mineral processing circuits; (e) provide value addition processing and beneficiation of local mineral and energy resources; (f) develop, produce and supply mining, mineral processing, automotive and agricultural equipment and spares and; (g) develop and produce refractories.

- **National Metrology Institute (NMI):** in line with its mandate and, in its capacity as custodian of National Measurement Standards, provides high-quality, traceable metrology services to support the competitiveness of Zimbabwean industrial products and services, fairness in trade, consumer protection, health and safety of human and animal life and environmental protection. The institute provides traceable measurements and calibration services to private as well as public sectors of the economy. These services enable industries to compete on global markets, as well as meet statutory and contractual obligations. NMI aims to: (a) deliver accurate and traceable results consistently through calibrations using measurements standards with demonstrated equivalence to those of other recognized national and internal metrology laboratories; (b) meet all customer requirements, as well as applicable regulatory, statutory and contractual requirements, and relevant national/international

standards; (c) respect the management's commitment to implementing ISO/IEC 17025 requirements and those of the accreditation body; (d) ensure that NMI's policies and procedures are documented, known, understood and implemented by all employees in executing their duties and; (e) sustain the technical competence of personnel through relevant training and intra- and inter-laboratory comparisons with peer laboratories.

- **Production Engineering Institute (PEI):** provides R&D in the mechanical, industrial and manufacturing, electrical and chemical engineering fields. The institute's goal is to develop competitive engineering products, machinery and manufacturing systems for the industrial and socio-economic development of Zimbabwe and the region.

Ministry of Agriculture, Mechanisation and Irrigation Development

Address: Ngungunyana Building, 1 Borrowable Road. Harare, Zimbabwe

Telephone: (+263)-4-790358/4-706081

Website: www.moa.gov.zw

Functions: to promote and sustain a viable agricultural sector and to develop and manage land resources through the provision of appropriate technical, administrative and advisory services, in order to optimize the functions of the system and contribute to equitable and sustainable socio-economic development in Zimbabwe. The Ministry of Agriculture, Mechanisation and Irrigation Development also undertakes agricultural research. The following departments come under the ministry: (1) Department of Agricultural Research and (2) National Veterinary Laboratory, (3) agricultural colleges and research institutes (see below for details).

AGRICULTURAL RESEARCH COUNCIL

Address: 79 Harare Drive, Marlborough, Harare, Zimbabwe

Telephone: (+263) - 4- 575 289

Historical Note: The Agricultural Research Council of Zimbabwe is a statutory body set up by the Agricultural Research Act (Chapter 18:05). It fulfils the following functions: (a) reviews agricultural research in Zimbabwe, paying particular attention to the adequacy of such research for the needs of Zimbabwe and; (b) promotes all aspects of agricultural research and ensures maximum co-ordination between persons or authorities undertaking, or about to undertake, any form of agricultural research.

In realization of the need for an interface between research and development, the council has assumed responsibility for facilitating the implementation of developmental activities related to, or emanating from, research output.

Objectives: the objective is to facilitate, co-ordinate, promote and review agricultural research and development in response to client, environmental and future needs of the agricultural sector. This is achieved through stakeholder-based participatory problem and solution identification, in collaboration with carefully selected, capable and innovative scientific and developmental personnel drawn from all sectors of the economy.

GRAIN MARKETING BOARD

Address: 67B Samora Machel Avenue, Eastlea, Harare, Zimbabwe

Telephone: (+263)–4-661836/665581

Website: www.gmbdura.co.zw

Historical Note: the Grain Marketing Board is the country's leading grain trader. Its objective is to ensure national food security through the efficient and sustainable management of the Strategic Grain Reserve. The Grain Marketing Board was established under the Maize Control Act of 1931. Its basic responsibilities were to accord producers their fair share of the local and export markets, to provide them with a guaranteed outlet for their excess controlled products and to ensure the availability of adequate supplies to satisfy local demand either from domestic production or from exports. These responsibilities have remained fundamentally unchanged, although many commodities have been brought under the control of the Grain Marketing Board in addition to maize.

DEPARTMENT OF RESEARCH AND SPECIALIST SERVICES

Address: Harare Research Centre, Fifth Street Extension, Harare, Zimbabwe

Telephone: (+263) -4-704531

Website: www.drss.gov.zw

Historical Note: the Department of Research and Specialist Services (DRSS) was established in 1948. It has three divisions: Division of Crops Research (with six institutes and a total complement of staff of 1 062); Division of Livestock and Pastures Research and Division of Research Services. The DRSS is headed by a principal director, with each of the three divisions being headed by a director.

Functions: The objective of the department is to provide research-based technologies, technical information for advisory services and products for supporting enhanced agricultural productivity and the production of various crops and livestock (with the exception of tobacco, tea, sugarcane, pigs and forestry). The technologies, knowledge and information are designed to: (a) facilitate improved or increased productivity per unit area or per resource quantum; (b) protect Zimbabwe's agriculture through the provision of a dependable, effective, efficient and competitive regulatory service that prevents the introduction of pests and diseases of quarantine importance and ensures availability of quality agricultural inputs and products; (c) deliver specialist services that promote sustainable agricultural and economic growth; (d) remove drudgery for farmers, speed up activities and save on time, physical and financial resources; (e) develop technologies for adding value to primary products to increase farmers' capacity to generate additional income and; (f) facilitate the development of agriculture by commercializing research-based technologies.

The Coffee Research Station, Cotton Research Station, Crop Breeding Institute, Grasslands Research Station, Henderson Research Station and Makoholi Research Institute are government institutions attached to the Department of Research and Specialist Services. All of these institutes are described hereafter.

COFFEE RESEARCH STATION

Address: Harare Research Centre, Fifth Street Extension, Harare, Zimbabwe

Telephone: (+263)-4- 704531

Website: www.drss.gov.zw

Objectives: the main objective of this institution is to establish and disseminate technologies for the sustainable production of coffee through appropriate and relevant research in Zimbabwe. The Coffee Research Institute is divided into three research sections, namely agronomy, pathology and entomology. These sections are a driving force behind the research programmes supported by the farm and administration. The Coffee Research Institute is a government institution under the Department of Research and Specialist Services.

The core functions of the institute are to: (a) conduct research for the development of appropriate and sustainable coffee production technologies; (b) package and disseminate relevant information on coffee production; (c) conduct extension services and farmer training courses on appropriate coffee production practices; (d) mobilize farmers who are new to coffee production; (e) characterize and conserve coffee genetic material; (f) produce planting materials for farmers; (g) evaluate pesticides and fertilizers for efficacy; (h) provide advisory services on coffee management and; (i) create linkages and partnerships with stakeholders in the coffee industry.

COTTON RESEARCH STATION

Address: Harare Research Centre, Fifth Street Extension, Harare, Zimbabwe

Telephone: (+263) - 4- 704531

Website: www.drss.gov.zw

Historical Note: the Cotton Research Station falls under the Crops Research Division of the Department of Research and Specialist Services.

The Department of Research and Specialist Services' objective is to develop and disseminate viable, practical and sustainable cotton production technologies that meet the needs of the cotton industry in Zimbabwe.

CROP BREEDING INSTITUTE

Address: Harare Research Centre, Fifth Street Extension, Harare, Zimbabwe

Telephone: (+263) - 4- 704531

Website: www.drss.gov.zw

Historical Note: the Crop Breeding Institute falls under the Crops Research Division of the Department of Research and Specialist Services. It is the government arm responsible for breeding and maintaining 13 field crop varieties, as well as availing breeder's seed for the 13 crop varieties to seed companies for further multiplication and certification. Since its inception in 1909, the institute has accumulated over 100 years of crop variety development.

The Crop Breeding Institute (CBI) was the first institution in the world (outside the United States of America) to release a single cross maize hybrid: SR52 in 1952. The CBI Maize breeding programme has won the best maize breeding team award for the southern African region for a record three times since 2009.

Objective: The mandate of the Crop Breeding Institute is to carry out research and development, provide advisory and technical services, farmer training, food technology and disseminate technologies; it also provides management and advisory services in relation to biodiversity, genetic conservation and sustainable farming under the theme of 'cultivate and take care'.

GRASSLANDS RESEARCH STATION

Address: Harare Research Centre, Fifth Street Extension, Harare, Zimbabwe

Telephone: (+263) - 4- 704531

Website: www.drss.gov.zw/grasslands

Historical Note: the Grasslands Research Station came into being in 1929 when the government bought three farms in Marondera which were consolidated into a single farm in order to satisfy the growing demand for agricultural research in the high-rainfall sand veld region. The main research focus was on dairy, beef, sheep and pasture production and research. The remaining part was farmed commercially for demonstrations. The station's main dam was built across the headwaters of the Hunyani River in 1954, making work with irrigated pastures possible. Studies on lamb production started in 1956 and on dairy work in 1966. Future success was largely dependent on the outcome of work with pasture legumes. The focus of the station research programme has since shifted from the needs of the minority large-scale commercial farmers to those of the and previously neglected majority, communal, small-scale farmers. In Zimbabwe, beef and dairy cattle play a significant role in the livelihoods of the community through the provision of meat, milk, draught and financial security. Exports of beef to the European Union bring in significant foreign currency. The Grasslands Research Station is a government institute under the Department of Research and Specialist Services.

Functions: there is a need to promote research that continually evaluates and develops cheaper alternative sources of feed, such as the use of crop residues, industrial by-products and home-grown feeds. There is also a need to improve pasture production, which is the cheapest form of livestock feed, especially in areas where beef is solely produced off the veld.

HENDERSON RESEARCH STATION

Address: P. Bag 457 Mazowe South, Zimbabwe

Telephone: (+263)-4-0753098

Website: www.drss.gov.zw/henderson

Historical Note: In terms of land area, Henderson Research Institute is the smallest of the four livestock research institutes under the Department of Research and Specialist Services. It was acquired by the government for research purposes in 1947.

Functions: the institute primarily carries out livestock research in the following disciplines: pasture, dairy, animal nutrition (beef and small ruminants), poultry farming and fisheries.

MAKHOLI EXPERIMENT STATION

Address: 35 B Masvingo Street, Masvingo, Zimbabwe

Telephone: (+263) - 039- 089 67834

Historical Note: the Makholi Experiment Station is a government research institution that is located 32 km north of Masvingo town. The Institute falls under the Livestock and Pasture Research Division of the Department of Research and Specialist Services (DR& SS) in the Ministry of Agriculture, Mechanization and Irrigation Development.

Functions: the Makholi Experiment Station develops technologies for sustainable intensive livestock production systems within the low-rainfall region/ agro-ecological regions four and five (Masvingo and Midlands provinces) using veld, improved pastures, home-grown crops and their residues. The institute assists in boosting agriculture production and poverty alleviation through: (a) maintenance of a reliable source of conserved indigenous animal and plant genetic materials for future use; (b) provision of

information on the use of Mashona cattle for beef production, dairy and beef production through Mashona cross breeding; (c) provision of information on improved poultry husbandry (indigenous poultry mainly) and goat production; (d) provision of information on pasture and forage production; (f) availing farmers with pure Mashona cattle for use in beef production systems; (g) availing farmers with Mashona dairy crossbreeds for use mainly in the smallholder dairy sector so as to boost/improve dairy production and; (h) the provision of pasture and forage seed (for example Leucena seed) and vegetative propagation material (such as Bana grass, which has been successfully evaluated for the region), at a subsidized cost so as to improve on the farmers' feed resource base.

NATIONAL VETERINARY LABORATORY

Address: Private Bag Harare, Zimbabwe

Telephone: +263 778071490

Executive head: Dr HFU Ushewekunze-Obatolu

Email: newazvo@hotmail.com / wotesa@yahoo.co.uk

Aims and Responsibilities: the core business of the National Veterinary Laboratory is to provide veterinary laboratory services (animal disease diagnosis, quality assurance testing of animal food products and quality assurance testing of animal feed) and to conduct applied research on public and animal health problems, in order to promote a diversified, sustainable and competitive livestock industry in Zimbabwe.

TOBACCO RESEARCH BOARD/KUTSAGA RESEARCH STATION

Address: Kutsaga Research Station, Airport Ring Rd, Harare, Zimbabwe

Telephone: (+263) - 4- 575289.

Website: www.kutsaga.co.zw

Historical Note: Most of the research done by the Tobacco Research Board takes place at Kutsaga Research Station, an agricultural research institute which dates from 1954 and is attached to the Ministry of Agriculture (see also Box 9).

Functions: the main research focus is on all aspects of growing, processing and marketing tobacco. The research station has a large staff complement which includes research scientists working in departments such as agronomy and physiology, plant breeding, soil chemistry, nematology, entomology, plant pathology and molecular biology. Kutsaga Research Station has exclusive rights to flue-cured research in Zimbabwe. All varieties of tobacco sold in Zimbabwe must be recommended by the Tobacco Research Board.

The Tobacco Research Board is currently involved in the following research activities: (a) agronomic work on the most efficient production methods and tobacco plant nutrition; (b) research on crop protection for tobacco, including integrated diseases and pest management; (c) development of appropriate technologies for small-scale producers; (d) pro-active generation of information, knowledge and technology to enable Zimbabwe tobacco farmers to attain the best yields of the highest-quality tobacco at the lowest cost; (e) provision of advice and assistance to any tobacco farmer; (f) co-ordination and promotion of health research.

MATOPOS AGRICULTURAL RESEARCH CENTRE

Address: Off Kezi Rd. Matopos, Bulawayo, Zimbabwe

Telephone: (+263)-4- 838 259/ 289/253

Website: www.cgiar.org

Historical Note: Matopos Research Station was established in 1903. Over the next 11 years, various agricultural trials and demonstrations were conducted involving a variety of crops, mainly irrigated wheat and Lucerne, cattle and veld burning. Subsequently, the land was farmed commercially until 1922. In 1923, the Department of Agriculture took over the farm and an agricultural institution was set up, including a School of Agriculture. In 1934, it became an experimental station. Cattle were the main subjects of investigation, although some crop research was also conducted.

Current Structure: Presently, Matopos Research Institute comprises an area of 28 000 hectares leased from the Rhodes Matopos Estate. Matopos Research Institute is managed by the head of the institute with the support of professional, technical, administration and support staff. Its organization is structured along the following sections: livestock nutrition, cattle production, analytical laboratory, small ruminant production, crop production, range and pastures, sorghum and millet research unit, crop production unit.

Ministry of Energy and Power Development

Address: Chaminuka Building, Ground Floor, Corner Central Avenue/Fifth Street, Harare, Zimbabwe

Telephone: (+263)-4-733095-9/4 799194

Website: www.energy.gov.zw

Objective: The objective of the Ministry of Energy and Power Development is to provide an enabling environment in which adequate, reliable, affordable and sustainable energy is made available to all, in an efficient manner.

ZIMBABWE ELECTRICITY SUPPLY AUTHORITY

Address: Electricity Centre, 25 Samora Machel Avenue, Harare, Zimbabwe

Telephone: +263-4- 4 773302/04-10

Website: www.zesa.co.zw

Functions: The Zimbabwe Electricity Supply Authority (ZESA), officially called ZESA Holdings Ltd, is the only power generator and supplier for the public grid. It has delegated power generation and distribution to its subsidiaries, the Zimbabwe Power Company formed in October 1996 and the Zimbabwe Electricity Distribution Company. A third subsidiary, ZESA Enterprises, serves as a flexible investment arm for ZESA Holdings Ltd with a diversified business portfolio. ZESA Enterprises comprises four business units, namely ZESA Technology Centre, Production and Services, Transport Logistics and Projects. Transmission grid assets and operations fall under the Zimbabwe Electricity Transmission Company (ZETCO).

ZIMBABWE ENERGY REGULATORY AUTHORITY

Address: 14th Floor, Century Towers, 45 Samora Machel Avenue. Harare, Zimbabwe

Telephone: (+263)-4-780010

Website: www.zera.co.zw

Historical Note: The Zimbabwe Energy Regulatory Authority (ZERA) was created in September 2011 following the promulgation of the Energy Regulatory Act (Chapter 13:23) which provides for regulation of the energy sector and other sections not provided for by the energy laws, the Electricity Act (13:19) and Petroleum Act (13:22). The Energy Regulatory Act repealed some sections especially those related to the formation of the regulatory institutions in the Electricity Act (Chapter 13:19) and Petroleum Act (Chapter 13:22). The mandate of ZERA is to regulate the Energy Sector in Zimbabwe.

RURAL ELECTRIFICATION AGENCY

Address: 6th Floor, Megawatt House, 44 Samora Machel Avenue, CBD Harare, Zimbabwe

Telephone: +263 (4) 731032

Email: rea@zesa.co.zw

Website: www.energy.gov.zw/index.php/power-development/rural-electrification-programme

Functions: Following the passing of two acts of Parliament in 2002, the Electricity Act (Chapter 13:19) and the Rural Electrification Fund Act (Chapter 13:20), comprehensive reforms were undertaken in the electricity industry. The latter act led to the establishment of the Rural Electrification Agency, the main focus of which is to spearhead rapid and equitable electrification of rural areas. According to the Ministry of Energy and Power Development, the Zimbabwe Rural Electrification Programme has seen more than 5 000 rural institutions, farms, villages, borehole, dam points and irrigation schemes electrified to date. There are two complementary components: under the Expanded Rural Electrification Programme, all rural public institutions qualify for a 100% capital subsidy (schools, clinics, government extension offices, chiefs' homesteads, etc) and all other rural electrification programmes qualify for a 60% capital subsidy; under the Electricity End-Use Infrastructure Development component, the productive use of electricity in irrigation and cottage industries is promoted to empower rural communities. The Rural Electrification Fund Act provides for the funding of the programme through levies, loans, fiscal allocations, grants and donations. At present, the programme is primarily funded by a 6% levy on all consumers of electricity, as well as by fiscal allocations.

According to a presentation by the Rural Electrification Agency[27] in September 2011, 40% of Zimbabweans have access to electricity, 80% in urban areas and 19% in rural areas.

27 see: www.sapp.co.zw/docs/ZIEPC%20&%20EXHIBITION%202%20(2).pdf

Ministry of Environment, Water and Climate

Address: Kaguvi Building, 11th Floor, Central Avenue, Harare, Zimbabwe

Telephone: (+263) -4-701681/5

Historical Note: At independence in 1980, the Government of Zimbabwe established the Ministry of Natural Resources and Tourism, which was basically mandated to protect Zimbabwe's natural resources and promote tourism. In the early 1990s, the Ministry was renamed the Ministry of Environment and Tourism. In 1997, the Ministry was reconstituted to include mining issues and became the Ministry of Mines, Environment and Tourism. In the year 2000, the mines aspect was separated and it reverted to the Ministry of Environment and Tourism.

The year 2009 saw the establishment of the Ministry of Environment and Natural Resources Management, the mandate of which shifted to concentrate on solely environmental issues. The portfolio of natural resources and environment has been growing over the years both nationally and globally. The mission of the new Ministry of Environment, Water and Climate is to promote best practices in environmental and natural resources management. The main focus of the Ministry is to ensure sustainable environmental management and use of the country's natural resources for the benefit of all Zimbabweans.

ZIMBABWE PARKS AND WILDLIFE MANAGEMENT AUTHORITY

Address: Botanical Garden, Borrowable Roads, Harare, Zimbabwe

Telephone: (+263)-4-706077/8

Website: www.zimparks.org

Historical Note: the Zimbabwe Parks and Wildlife Management Authority operates under the Parks and Wildlife Act of 1975.

Functions: the authority manages one of the country's largest estates, about 5 million hectares of land or 13% of Zimbabwe's total land area. It should be noted that most of the parks are located in Ecological Regions Four and Five or rugged mountainous areas which would not have much alternative economic use. The authority is mandated to protect, manage and administer all the wildlife in Zimbabwe, be it on private or communal lands.

ENVIRONMENTAL MANAGEMENT AGENCY

Address: Makombe Complex, Harare Street / Herbert Chitepo Avenue, Harare, Zimbabwe

Telephone: (+263)-4-705671-3 / 705661-2

Website: www.ema.co.zw

Historical Note: the Environmental Management Agency is a statutory body established under the Environmental Management Act (Chapter 20:27) and enacted in 2002.

Functions: the Environmental Management Agency is responsible for ensuring the sustainable management of natural resources and protection of the environment, the prevention of pollution and environmental degradation, and the preparation of environmental plans for the management and protection of the environment.

Ministry of Finance and Economic Development

Address: New Complex Building, Government Composite Offices, Corner 3rd St/ Samora Machel Avenue, Harare, Zimbabwe

Telephone: (+263)-4 - 04252936

Website: www.zimtreasury.gov.zw

Functions: the ministry formulates and co-ordinates sound macro-economic policies, effectively mobilizing, allocating, managing and accounting for public resources. The overall functions of the ministry are to: (a) manage the consolidated revenue fund, the national development fund and the public debt portfolio; (b) formulate and administer the National Accounting Policy; formulate and administer the national budget; (c) design and implement up-to-date, effective systems of internal check and control; (d) mobilize financial resources to finance government programmes; (e) facilitate and participate in negotiations related to mobilizing resources at domestic and international levels and; (f) collect revenue due to the government, in particular through the Zimbabwe Revenue Authority (ZIMRA).

The ministry has the following departments: Accountant General, Debt Management Office, Fiscal Policy and Advisory Services, Expenditure Department, Revenue Department, Domestic and International Finance, Implementation and Control of Expenditure, Internal Audit. Under the Minister of Finance and Economic Development, the administrative head and accounting officer is the Permanent Secretary, who is assisted by four principal directors.

INDUSTRIAL DEVELOPMENT CORPORATION OF ZIMBABWE

Address: Industrial Development Corporation of Zimbabwe Limited, 93 Park Lane, Harare, Zimbabwe

Telephone: (263)-4 -706971

Website: www.idc.co.zw

Historical Note: the Industrial Development Corporation of Zimbabwe Ltd was established in 1963 through an act of Parliament (Chapter 14:10). The Industrial Development Corporation of Zimbabwe Ltd is wholly owned by the Government of Zimbabwe and is, accordingly, a state enterprise. It is unique in having been a commercial entity from the outset, as it is also registered under the Companies Act (Section 3) of Zimbabwe. The corporation has limited liability. The Act of Parliament of 1963 (Chapter 14:10) allows the corporation to promote investment and economic co-operation across borders. The act stipulates that all undertakings of the corporation should be considered strictly on their economic merits. Accordingly, the corporation is specifically prohibited from serving a purely social or benevolent function. It is therefore required to operate on a financially self-sustaining basis, irrespective of other considerations.

Functions: the economic role of the Industrial Development Corporation of Zimbabwe Ltd is to add value through industrial processes and capital formation (foreign direct investment), to create wealth, employment and industrial development in Zimbabwe.

The corporation is mandated to: (a) establish and conduct any industrial undertaking, to facilitate, promote, guide and assist the financing of: new industrial undertakings (including small and medium scale), schemes concerning the expansion, better organization, modernization and implementation of operations in existing industries and industrial undertakings; (b) implement government policy in regard to decentralization of industry, choice of technology and any other matter which the Minister of Industry and Commerce may specify; (c) develop management and technical expertise in carrying out industrial undertakings and; (d) take measures to acquire direct and effective control of the corporation's investments and, to that end, ensure that industrial development in Zimbabwe may be planned, expedited and conducted in accordance with business principles.

ZIMBABWE ECONOMIC POLICY RESEARCH ANALYSIS UNIT

Address: 55 Mull Avenue, Belvedere, Harare, Zimbabwe

Telephone: (+263) -4-778423

Website: www.zeparu.co.zw

Historical Note: the Zimbabwe Economic Policy Analysis Research Unit (ZEPARU) is an autonomous think tank established by a Deed of Trust on 14 March 2003, following the signing of a Grant Agreement between the Government of Zimbabwe and the African Capacity Building Foundation on 5 October 2001.

Functions: the role of ZEPARU is to: (a) promote and conduct research and analysis on macro-economic and development policy issues which are of relevance to Zimbabwe; (b) monitor the performance of the Zimbabwean economy and the management of public policy implementation, especially with regard to the implications for socio-economic development; (c) offer advice and provide consultancy services to government agencies and other clients under suitable contractual or other arrangements; (d) provide technical and financial assistance, directly or indirectly, to individuals and organizations in Zimbabwe for the purpose of facilitating policy analysis; (e) assist in professional training and development activities targeting the government and other stakeholders to strengthen national policy analysis and management capacity; (f) encourage collaborative research and policy analysis and work with local and foreign institutions to build national performance and understanding of policy analysis; (g) employ staff members who will themselves, or jointly with other organizations or qualified people, carry out research, consultancies, training and education projects, including the arrangement of contractual relationships designed to facilitate such activities by persons affiliated with the Trust; and (h) present or publish, as the case may be, the outcome of its policy analysis, orally or in writing, to individuals, organizations or the general public.

ZIMBABWE NATIONAL STATISTICS AGENCY

Address: Makombe Building, Corner Harare Street/ Herbert Chitepo, Harare, Zimbabwe

Telephone: (+263)-4-703977

Website: www.zimstat.co.zw

Historical Note: the Zimbabwe National Statistics Agency (ZIMStat) is a corporate body that was established through the Census and Statistics Act of 2007.

Functions: ZIMStat provides reliable and up-to-date statistics to the government, scientists, industry and commerce, international bodies and the public in general. The main source of official statistics in Zimbabwe the agency plays a co-ordination and supervisory role within the national statistical system. ZIMStats has the authority to certify and designate any statistics produced in the country as official statistics having satisfied all quality requirements. The agency's operations are controlled and managed by the Board of Directors which is appointed by the Minister of Finance and Economic Development.

ZIMBABWE REVENUE AUTHORITY

Address: ZB Centre, Corner Nkwame Nkrumah Avenue/ First Street, Harare, Zimbabwe

Telephone: (+263) -4-758 891-5, 790 813, 790 814

Website: www.zimra.co.zw

Historical Note: the Zimbabwe Revenue Authority (ZIMRA) was established on 19 January 2001 as a successor to the Department of Taxes and the Department of Customs and Excise, following the promulgation of the Revenue Authority Act on 11 February 2000. The Zimbabwe Revenue Authority derives its mandate from the Revenue Authority Act [Chapter 23:11] and other subsidiary legislation.

Functions: the Zimbabwe Revenue Authority (ZIMRA) is responsible for assessing, collecting and accounting for revenue on behalf of the state through the Ministry of Finance and Economic Development.

Ministry of Health and Child Care

Address: Kaguvi Building, 4th Floor, Central Avenue, Harare, Zimbabwe

Telephone: (+263)-4-798537-60

Website: www.mohcc.gov.zw

Functions: the mission of the Ministry of Health and Child Care is to mobilize resources for the provision of health services, distribute the same equitably and ensure proper financial management and control of funds. One of the ministry's key objectives is to commission systems research in health financing.

MEDICINE CONTROL AUTHORITY OF ZIMBABWE

Address: 106 Baines Avenue**,** Harare, Zimbabwe**.**

Telephone: (+263)-4 -736981-5, +263-4-708255, +263-4-792165, +263-4-2901327

Website: www.mcaz.co.zw

Historical Note: the Medicines Control Authority of Zimbabwe is a statutory body established by an act of Parliament, the Medicines and Allied Substances Control Act (Chapter 15.03). The Medicines Control Authority of Zimbabwe is a successor to the Drugs Control Council and the Zimbabwe Regional Drug Control Laboratory. The Drugs Control Council was established by an act of Parliament in 1969, the Drugs and Allied Substances Control Act (Chapter 15.03). The Zimbabwe Regional Drug Control Laboratory became operational in 1989.

Function: the Medicine Control Authority of Zimbabwe is responsible for protecting public and animal health by ensuring that accessible medicines and allied substances and medical devices are safe, effective and of good quality through the enforcement of adherence standards by manufacturers and distributors.

MEDICAL RESEARCH COUNCIL OF ZIMBABWE

Address: Corner Josiah Tongogara/Mazowe Street, Harare, Zimbabwe

Telephone: (+263)-4-78904/791792/791133

Historical Note: the Medical Research Council of Zimbabwe was established in 1974 under the Research Act of 1959, in order to provide health researchers and institutions with a platform for their research and independent ethical oversight on research conducted by them. It is composed of scientists, medical experts, ethicists, lawyer and religious community representatives. It is independent in its reflection, advice and decision-making.

Functions: the Medical Research Council of Zimbabwe's mandate is to co-ordinate and promote the ethical conduct of health research and influence health policy and practice in Zimbabwe.

NATIONAL AIDS COUNCIL OF ZIMBABWE

Address: 100 Central Avenue, Harare, Zimbabwe

Telephone: (+263)-4-791170

Website: www.nac.org.zw

The objective of the National Aids Council is to facilitate and support the establishment and operation of co-ordination mechanisms for sectorial and district/community action on HIV and AIDS, by: (1) providing guidance and technical support for sectorial and district/ community strategic planning and priority-setting for HIV and AIDS; (2) supporting implementation of sectorial and community/district responses to HIV and AIDS; (3) mobilizing and managing resources and; (4) ensuring transparency and accountability in the utilization of mobilized resources.

NATIONAL INSTITUTE FOR HEALTH RESEARCH

Address: 16C Josiah Tongogara/Mazowe Street, Harare, Zimbabwe

Telephone: (+263)-4 -78904

Historical Note: the National Institute for Health Research was known as the Blair Research Institute until 2011. The Blair Research Institute was founded in 1939. Since independence, it has become known nationally and internationally for its work on the Blair latrine and Blair simple hand pump, bucket pump and bush pump. These technologies were developed locally with the aim of providing safe water and an acceptable excreta disposal system.

Functions: the National Institute for Health Research is an institution under the Ministry of Health and Child Care and is an affiliate of the University of Zimbabwe. Its functions include research and control of vector-borne diseases and other tropical infections, health technology development, health impact and evaluation, training and services.

Ministry of Higher and Tertiary Education, Science and Technology Development

ZIMBABWE COUNCIL OF HIGHER EDUCATION

Address: 21 Airport Road, Hatfield, Zimbabwe

Telephone: (+263) -4- 571163.

The Zimbabwe Council of Higher Education is a statutory body created through an act of Parliament of 2006 (Chapter 25:27). It has the mandate to register and accredit institutions of higher education in Zimbabwe. It determines and maintains standards of teaching, examinations, academic qualifications and research in institutions of higher education.

ZIMBABWE MANPOWER DEVELOPMENT FUND

Address: CABS Centre, Kwame Nkrumah Avenue, 1st Floor, Harare, Zimbabwe

Telephone: (+263) -4- 707266/9

Website: www.zimdef.org.zw

Historical Note: The Zimbabwe Manpower Development Fund (ZIMDEF) was established by section 23 of the Manpower Planning and Development Act of 1984 (since revised by the Manpower Planning and Development Act of 1996 (Chapter 28:02).

Functions: the fund has the broad objective of financing the development of critical and highly skilled human resources in Zimbabwe. The aim is to contribute to national human capital development through resource mobilization, management and disbursement for the benefit of clients.

Ministry of Justice, Legal and Parliamentary Affairs

Address: New Government, Complex Corner Samora Machel / Fourth Street, Harare, Zimbabwe

Telephone: (+263)-4-4774560/ 774620/7

Website: www.justice.gov.zw

Functions: the ministry's objective is to promote an effective justice delivery system and provide legal services, the rehabilitation of prisoners and guarantee good governance and democracy while promoting the rule of law. The following departments fall under the ministry: Attorney General's Office, Zimbabwe Prison Services, Community Service, Legal Aid Directorate, Law Development Commission, Policy and Legal Research, Internal Audit, Pre-Trial Diversion, Council for Legal Education, Constitutional and Parliamentary Affairs.

PATENT OFFICE

Address: Century House East, 38 Nelson Mandela Avenue, Harare, Zimbabwe. P.O Box CY 177, Causeway, Harare, Zimbabwe

Telephone: (+263) - 4-775 544 / 6 (263 4) 775 602, (263 4) 777 373

The function of the Patent Office is to protect intellectual property, which comprises patents, trademarks and industrial designs.

Ministry of Mines and Mining Development

Address: Zimre Centre, 6th Floor, Corner Leopold Takawira /Kwame Nkrumah Avenue, Harare, Zimbabwe

Telephone: (+263)-4-777022

Website: www.mines.gov.zw

Functions: the following departments fall under the Ministry of Mines and Mining Development: Metallurgy, Mining Law and Administration, Mining Promotion and Development, and the Geological Survey. The ministry is also responsible for surveying and exploring all minerals for the purposes of mining and metallurgy of non-ferrous metals like aluminium, copper, zinc, lead, gold and nickel.

CHAMBER OF MINES

Address: 3rd Floor, Charter House, Corner Samora Machel Avenue and Julius Nyerere, Harare, Zimbabwe

Website: www.chamberofminesofzimbabwe.com

The Chamber of Mines is a voluntary organization established in 1939 by an act of Parliament. The members include mining companies, suppliers of machinery, spare parts, and chemicals, service providers (including banks), insurance companies, consulting engineers and various mining related professional bodies and individuals. The mining company members of the Chamber of Mines produce about 90% of Zimbabwe's total mineral output.

The Chamber of Mines' primary objectives are to advocate and lobby, in order to promote, encourage and protect the interests of Zimbabwe's mining industry in the following areas: economic policy, mining sector policy, investment promotion, labour and industrial relations management, research on legal matters related to mining, representation of the views of industry to government and other stakeholders, as well as the provision of a variety of services aimed at promoting health and safety, training, environmental protection and the support of mining associations.

In August 2012, the Chamber of Mines signed a Memorandum of Agreement with the Institute of Mining Research (University of Zimbabwe) and the Platinum Producers Committee for the launch of a collaborative research project.

MINERALS MARKETING CORPORATION OF ZIMBABWE

Address: 90 Mutare Road, Msasa, Harare, Zimbabwe

Telephone: (+263)-4-487200-4

Website: www.mmcz.co.zw

The objectives of the Minerals Marketing Corporation of Zimbabwe are to: (a) act as the sole marketing and selling agent for all minerals; (b) investigate marketing conditions for minerals in general or for any particular mineral, or cause these to be investigated, in or outside Zimbabwe; (c) purchase or otherwise acquire any minerals and sell or dispose of such minerals; (d) encourage the local beneficiation and utilization of any minerals and; (e) advise the minister on all matters connected with the marketing of minerals.

ZIMBABWE GEOLOGICAL SURVEY DEPARTMENT

Address: P.O. Box 210; Causeway, Harare, Zimbabwe

Historical Note: The Zimbabwe Geological Survey Department was established in 1910. Some of its early activities include free mineralogical determinations of mineral specimens and chemical analyses of ores and mineral concentrates for the public. These activities proved to be most popular with prospectors and led to the development of many mineral prospects, notably the 1960s nickel boom.

Independence in 1980 drew enormous interest in the mining potential of Zimbabwe and a number of technical co-operation agreements to undertake geological work were concluded. This resulted in the expansion of geological work and the provision of equipment to the Geological Survey, as well as the training of geoscientists and technicians. However, the 1990s were accompanied by a serious erosion of staff and the beginning of a decline in the department's activities. Few locally trained geologists stayed long and this was compounded by the gradual withdrawal of co-operative technical aid and the economic challenges faced by the country, leading to a serious deterioration in the functionality of the Geological Survey.

Functions: the Geological Survey provides quality geo-scientific information and services for the exploration and development of the country's mineral resources. It compiles geoscientific information of the earth's crust through the systematic geological mapping of rock formations and general cataloguing and description of mineral resources.

In addition to the Geology Survey, the Ministry of Mines and Mining Development has two other departments with the following functions:

Mining Engineering Department: this department regulates the mining industry to ensure sustainable mining and managerial practices for the purpose of creating a safe and healthy mine environment.

Metallurgy Department: this department is responsible for developing sustainable, responsible mineral processing, for verifying the technical and economic feasibility for beneficiation and for marketing mineral resources and minerals. Its work is complemented by that of the Metallurgical Research Institute at SIRDC (see page 119), which provides testing and analytical services as well as a foundry for production.

Science Academy

ZIMBAWE ACADEMY OF SCIENCES

It was a background study of the existing academies of sciences in the world, conducted by the Research Council of Zimbabwe (see Box 15), which laid the foundations for the establishment of the Zimbabwe Academy of Sciences. Discussions were held informally with a number of professional bodies to rationalize the need for a National Academy of Sciences in Zimbabwe. Several policy-makers consulted by the founding committee registered their support for the academy, which was ultimately established in October 2004.

A decade later, the Zimbabwe Academy of Sciences counts 87 Fellows out of a potential maximum of 120 Fellows, as prescribed by the constitution. The Fellows are grouped into three categories: (a) College of Life Sciences (39 Fellows); (b) College of Physical Sciences (31 Fellows) and (c) College of Social Sciences (17 Fellows). The Academy of Sciences is in the process of organizing a young scientist affiliate arm. The academy is also working hard to expand its female membership. To date, only 14 of the Fellows are women.

The Executive Committee provides leadership. It consists of a president, vice-president, secretary-general, honorary treasurer and a dean for each of the three colleges, as well as a committee member from each of the three colleges. Every three years, members of the Executive Committee are elected by a secret ballot at the Annual General Meeting.

The Zimbabwe Academy of Sciences publishes a quarterly *Newsletter* and the *Zimbabwe Journal of Science* (there is an effort underway to publish the latter as an e-journal). Other publications are posted on the academy's website.

Students from Zimbabwe's 13 universities compete annually for three national prizes awarded by the academy, one in life sciences, one in physical sciences and a third in social sciences. The highly coveted national award goes to the three final-year university students who graduate with the highest marks.

Fellows of the Zimbabwe Academy of Sciences serve the government and civil society by providing independent, evidence-based advice. The academy sees its role in advizing the government as part of its core raison *d'être*. Fellows frequently serve as authoritative sources of cutting-edge scientific information. The academy also mobilizes its intellectual resources to strengthening the national resolve when it comes to empowering women, fine-tuning the accent on youth and ensuring a purposeful confrontation with poverty, all done in a manner that safeguards the environment.

The academy works hard to assist Zimbabwe in keeping up with the ever-accelerating pace of ICT development, which can be harnessed by the country to improve the reach and delivery of its development programmes.

The academy is a member of the Network of African Science Academies, Word Academy of Sciences for the Advancement of Science in Developing Countries (TWAS) and Global Network of Academies of Sciences.

INSTITUTIONS OF HIGHER EDUCATION

In 1980, the government embarked on a major programme to extend educational access to the hitherto underserved population at both primary and secondary school levels. This exercise was primarily meant to address historical imbalances in the human resource base born out of the discriminatory education system prevalent before independence. Between 1979 and 1988, enrolment in primary schools rose from 819 000 to 2.2 million and secondary school enrolment from 66 000 to 653 353.

Such rapid expansion made it imperative for the Ministry of Higher and Tertiary Education to provide greater access to tertiary education, in order to absorb the overflow of secondary school graduates and relieve pressure on the sole public tertiary institutions at the time, the long-standing University of Zimbabwe and newly established National University of Science and Technology (est. 1991). In 1995, the Chetsanga Commission – named after the President of the Academy of Sciences – published a report recommending the conversion of teachers colleges and technical colleges into degree-granting institutions that would ultimately become universities in their own right, as a means of expanding access to higher education. The Ministry of Higher Education and Technology followed up this recommendation by adopting a policy of devolution.

To date, the government has facilitated the establishment of seven state universities. Three more are planned, in order to complete the network of provincial universities.

The country's public and private universities are described on the following pages.

AFRICA UNIVERSITY

Located just outside the eastern highlands city of Mutare in Zimbabwe, Africa University is a private university founded in March 1992 by the United Methodist Church worldwide. The university welcomes students from all over Africa without regard for race, class, ethnicity or political or religious affiliation.

Vision: become a world-class university for leadership development in Africa.

Mission: to provide quality education in a Pan-African context, through which persons can acquire general and professional knowledge and skills, grow in spiritual maturity and develop sound moral values, ethics and leadership qualities.

Table 35: Faculties and programmes in SETI at Africa University

Faculties and schools	Undergraduate Programmes	Postgraduate Programmes
Faculty of Agriculture and Natural Resources	• BSc in Agriculture & Natural Resources • BSc in Natural Resources Management • BSc in Agribusiness	• Master of Philosophy (MPhil) • MSc in Crop Production • MSc in Agribusiness
Faculty of Education	• Bachelor of Science in Agriculture with Education	• MPhil and PhD in Statistics
Faculty of Health Sciences	• Post Basic Bachelor of Nursing Science full-time (2 years) • Post Basic Bachelor of Nursing Science part-time (3 years) • Bachelor of Health Services Management (4 years) • Bachelor of Medical Laboratory Technology (4 years)	• Master of Public Health fulltime (2years) • Master of Public Health part-time (3 years)

Source: Africa University

BINDURA UNIVERSITY OF SCIENCE EDUCATION

In 1995, the government decided to address the shortage of science teachers locally by setting up a University of Science Education. The Bindura University College of Science Education was established under the University of Zimbabwe. Arrangements were made for it to be housed at the Provincial Public Service Training Centre in Bindura.

The college opened on 26 March 1996 with an intake of 125 students. Among the staff were five lecturers from Cuba. This development was partly a consequence of the termination of the Zimbabwe-Cuba Science Teacher Training programme which had begun operating in the mid-1980s. The University Council then set up a Planning Committee which was charged with the responsibility of transforming the college into a university within five years.

The government gazetted the Bindura University of Science Education Act in February 2000, conferring university status on the college. Since its inception, the university has been operating from the Public Service Training Centre on a temporary basis, pending construction of the main campus. This is being built on a 159-hectare plot about 2 km from the town centre along the Bindura-Mount Darwin Road

Vision: to become a hub of knowledge and a beacon of excellence in teaching, research and extension services.

Mission: to contribute to the development of Zimbabwe through the advancement of knowledge and skills in science education. It seeks to produce innovative and highly competent graduates equipped with research, entrepreneurial and technical skills for the benefit of the nation and the international community.

Core Values: learning, diversity, leadership, integrity, excellence, student focus, discipline and commitment.

Table 36: Faculties and programmes in SETI at the Bindura University College of Science Education

Faculties and schools	Undergraduate Programmes	Postgraduate Programmes
Faculty of Agriculture and Environmental science	• Bachelor of Science Honours Degree in Agricultural Economics and Management • Bachelor of Science Honours Degree in Agricultural Education and Extension • Bachelor of Science Honours Degree in Animal Science • Bachelor of Science Honours Degree in Crop Science • Bachelor of Science Honours Degree in Horticultural Science • Bachelor of Environmental Science Honours Degree in Forestry • Bachelor of Environmental Science Honours Degree in Wildlife and Rangeland Ecology • Bachelor of Environmental Science Honours Degree in Pollution Science • Bachelor of Environmental Science Honours Degree in Land Conservation and Reclamation • Bachelor of Environmental Science Honours Degree in Safety Health and Environmental Management • Bachelor of Environmental Science Honours Degree in Natural Resources Management	• Master of Science in Agroforestry
Faculty of Sciences	• Bachelor of Science Honours Degree in Biological Sciences • Bachelor of Science Honours Degree in Chemical Technology • Bachelor of Science Honours Degree in Development Studies • Bachelor of Science Honours Degree in Disaster Management Studies • Bachelor of Science Honours Degree in Applied Mathematics • Bachelor of Science Honours Degree in Physics with Computer Technology • Bachelor of Science Honours Degree in Computer Science • Bachelor of Science Honours in Sport Administration • Bachelor of Science Honours Degree in Nursing Education	• Master of Science in Analytical Chemistry • Master of Science in Conservation Biology • Master of Science Degree in Environmental Physics • Master of Science in Natural Resources Management
Faculty of Science Education	• Bachelor of Science Education General Degree, 3 years Options: |Biological Sciences | Chemistry | Geography • Bachelor of Science Education Honours Degree, 3 years Options: | Biological Sciences | Chemistry | Computer Science • Bachelor of Science Education Honours Degree, 4 years Options: | Biological Sciences | Chemistry | Physics | Mathematics | Computer Science	• Master of Science Education Degree • Options: | Biology | Chemistry | Physics | Mathematics | Geography | Computer Science

Source: Bindura University of Science Education

CHINHOYI UNIVERSITY OF TECHNOLOGY

Chinhoyi University of Technology started out as a twin degree programme under the auspices of the University of Zimbabwe. The two degree programmes offered were Production Engineering and Hospitality and Tourism. The degree programme was established in 1999, further to the recommendations of the Chetsanga Commission to devolve Chinhoyi Technical Teachers College and other similar colleges into degree-granting institutions.

The university has experienced steady growth, resulting in the introduction of four schools and an institute, namely the School of Engineering Science and Technology, School of Agricultural Sciences and Technology, School of Business Science and Management, School of Hospitality and Tourism and, lastly, the Institute of Lifelong Learning. These schools and the institute together house a total of 16 departments.

Vision: to become a world-class centre of excellence for technological innovation and entrepreneurship

Mission: to produce innovative graduates, create knowledge, enhance entrepreneurship and provide community service through quality teaching, training and technologically oriented research

Core Values: integrity, excellence, dynamism, entrepreneurship, democracy and culture.

Table 37: Schools and programmes in SETI at Chinhoyi University of Technology in Zimbabwe

Faculties and schools	Undergraduate Programmes
School of Agricultural Science and Technology	• Bachelor of Technology Honours Degree in Agricultural Engineering • Bachelor of Science (Honours) in Animal Production and Technology • Bachelor of Science Honours Degree in Environmental Science and Technology • Bachelor of Technology (Honours) Irrigation Engineering • Bachelor of Science Honours Degree in Biotechnology • Bachelor of Science Honours Degree in Food Science and Post-Harvest Technology • Bachelor of Science Honours in Crop Science and Technology • Bachelor of Science (Honours) in Environmental Engineering
School of Art and Design	• Bachelor of Science in Creative Art and Design • Bachelor of Science in Fine Arts • Bachelor of Technology Honours Degree in Clothing and Fashion Design
School of Engineering Science and Technology	• Bachelor of Engineering Honours Degree in Mechatronic Engineering • Bachelor of Technology Honours in Fuels and Energy Engineering • Bachelor of Technology Honours Degree in Computing and Information Technology • Bachelor of Technology Honours Degree in Production Engineering
School of Hospitality and Tourism	• Bachelor of Science (Honours) degree in Water Resources and Fishery Sciences
School of Natural Sciences and Mathematics	• Bachelor of Science (Honours) degree in Nanotechnology • Bachelor of Science (Honours) degree in Applied Physics • Bachelor of Science (Honours) degree in Biology • Bachelor of Science (Honours) degree in Chemistry • Bachelor of Science (Honours) degree in Mathematics

Source: Chinhoyi University of Technology

GREAT ZIMBABWE UNIVERSITY

The Great Zimbabwe University is currently situated 7 km east of Masvingo town along the Old Great Zimbabwe Road at Masvingo Teachers' College. Its main location is going to be 30 km from the city of Masvingo, near the Great Zimbabwe Monuments, where a bigger university campus will be built. The university offers a unique opportunity to study in a serene environment close to the famous world heritage site, the Great Zimbabwe Monuments, and also close to the biggest inland dam in the country, Lake Mutirikwi, as well as Kyle National Park. The city of Masvingo is equidistant from Harare, Bulawayo, Mutare and Beitbridge.

Vision: to become a centre of excellence in the arts, culture and heritage

Mission: to provide a learning environment in the quest for new knowledge and experience through creativity and cultural enrichment as a strategy for solving real-life development and existential problems

Core Values: efficiency, effectiveness and excellence in the provision of services to all our clients and stakeholders.

Table 38: Faculties and programmes in SETI at the Great Zimbabwe University

	Undergraduate Programmes
Faculty of Agriculture and Natural Sciences	BSc Honours Degree in Computer Science
	BSc Honours Degree in Mathematics
	BSc Honours Degree in Statistics and Operations Research
	BSc Honours Degree in Geography and Environmental Science
	BSc Honours Degree in Physics

Source: Great Zimbabwe University

GWANDA STATE UNIVERSITY

Gwanda State University is due to open in Gwanda in 2014. The university will be hosted by the Joshua Mqabuko Nkomo Polytechnic in Gwanda, while permanent facilities are under construction.

It is planned that the university will start with two faculties, the Faulty of Mining Engineering and the Faculty of Agriculture, with a Faculty of Industrial Management to follow later. The main campus shall be on an 87-hectare site in Gwanda, with a 2.5 ha farm in Filabusi.

HARARE INSTITUTE OF TECHNOLOGY

The Harare Institute of Technology was established in 1988 as a National Vocational Training Centre. Overtime, it evolved into a technical college offering courses in automotive, electrical and mechanical engineering. It produced artisans capable of operating and maintaining machinery in industry, with little or no research or generation of new technology-related knowledge.

The Harare Institute of Technology was granted degree-awarding status in 2005 with the promulgation of the Harare Institute of Technology Act [Chapter 25:26].

The Harare Institute of Technology conducts research and is active in design and manufacturing. It incubates, transfers and commercializes technology for all sectors of the economy. Its degree programmes fall under four schools.

Vision: produce highly qualified technical people who are creativity-driven, project-oriented, cognisant of all stages of invention and desirous to set up high-tech enterprises.

The Harare Institute of Technology runs the following SETI centres:

Technopreneurship Development Centre: offering both corporate and student courses that link technology with business development systems.

Teaching and Learning Centre: focusing on the use of technology in teaching and learning at postgraduate level; the centre designs/reviews curricula and learning strategies.

Technology Centre: promoting the development of prototypes and the manufactue of products generated by the other schools and centres. The centre serves the needs of industry, including manufacturing SMEs. Complementary wings of the Technology Centre are the Technical Training Unit and Production Unit, which provide services that include advanced training in tool and dye-making, computer numerically controlled devices, technology and printed circuit boards, manufacturing for individuals and companies.

Business Units: the Harare Institute of Technology is setting up a science park through a registered special purpose vehicle named Insti-Tech Holdings, targeting the commercialization of successful research prototypes. Insti-Tech Holdings will have separate companies, such as Insti Foods, which is producing soy-yoghurt, soy-milk, soysour milk, ice cream and mineral water, and Insti Soft, which is involved in software development.

The Harare Institute of Technology boasts of equipment acquired through the Indo-Zimbabwe Project. Complementary building plans have been developed covering a site in Harare, five industrial stands in the city of Harare and a farm in Beatrice (200 hectares) for raw materials that will feed into Insti Foods as well as commercial farming. The farm may grow food for students and has a big dam with irrigation facilities.

Table 39: Schools and programmes in SETI at the Harare Institute of Technology in Zimbabwe

School of Industrial Sciences and Technology	Bachelor of Technology (Honours) Food Processing Technology
	Bachelor of Technology (Honours) Biotechnology
	Bachelor of Technology (Honours) Pharmaceutical Technology
School of Engineering and Technology	Bachelor of Technology (Honours) Industrial & Manufacturing Engineering Technology
	Bachelor of Technology (Honours) Electronic Engineering
	Bachelor of Technology (Honours) Chemical & Process Systems Engineering
	Bachelor of Technology (Honours) Polymer Technology
	Bachelor of Technology (Honours) Materials Engineering
School of Information Science and Technology	Bachelor of Technology (Honours) Degree in Computer Science
	Bachelor of Technology (Honours) Degree in Software Engineering
	Bachelor of Technology (Honours) Degree in Information Security and Assurance
	Bachelor of Technology (Honours) Degree in Information Technology
School of Business and Management Sciences	B Tech (Honours) Financial Engineering
	B Tech (Honours) E-Commerce

Source: Harare Institute of Technology

LUPANE STATE UNIVERSITY

Lupane State University was established through an act of Parliament in 2004 and opened its doors to 14 pioneer students enrolled in the Faculty of Agricultural Sciences in August 2005.

Vision: to be an international premier university in research-based knowledge, teaching and learning

Mission: to contribute research-based knowledge and learning for the development of humanity by working closely with communities and attracting the best academics, researchers and students in Zimbabwe and beyond.

Core Values: professionalism, accountability, transparency, diversity, social and environmental responsibility.

Table 40: Faculties and programmes in SETI at Lupane State University

Faculty of Agricultural Science	BSc Honours in Animal and Rangeland Management
	Bachelor of Agricultural Sciences Honours degree in Crop Sciences
	Bachelor of Agricultural Sciences Honours degree Soil Sciences,
	BSc Honours Degrees in Irrigation Engineering
	BSc Honours Degrees in Environmental Management
	BSc in Irrigation Engineering

Source: Lupane State University

MIDLANDS STATE UNIVERSITY

The idea of a university in the Midlands dates back to the founding of the National University of Science and Technology in 1991, when the city of Gweru, which had been identified as a possible site for a second university campus in the country, lost its bid to Bulawayo. Two other opportunities to host institutions of higher learning (the Open University and the Catholic University) were also missed by the Midlands Province, when both universities went to Harare instead.

It was in the midst of such disappointments that two initiatives gradually converged to give birth to what was to become the Midlands State University. This coincided with the then Ministry of Higher Education and Technology's policy of devolution, which sought to expand access to higher education by converting teachers colleges and technical colleges into degree-granting institutions. It was through this process of devolution that, beginning in 1998, Gweru Teachers College started enrolling students studying for a Bachelor of Commerce with Education degree or a Bachelor of Science with Education degree offered by the University of Zimbabwe. The new university, later renamed Midlands State University, was initially housed on the premises of Gweru Teachers College.

The goal of Midlands State University is to establish ten faculties by 2015. To date, the university offers degree programmes spread across seven faculties: Arts, Commerce, Education, Law, Natural Resources Management and Agriculture, Science and Technology, Social Sciences.

Midlands State University is a fully semesterised and modularized university. Enrolment takes place twice a year, in March and August. Modules offered at any level in a semester are available at the same level during the next semester. This arrangement gives students a second chance to pass any modules they may have failed.

Vision: to be a unique, development-oriented, pace-setting and stakeholder-driven university that produces innovative and enterprizing graduates

Mission: (1) to promote a culture of problem-solving through quality research, teaching and training by means of flexible packaging, work-related learning and strategic partnerships with the university's stakeholders for the immediate and ultimate benefit of humanity; (2)to improve the country's economic performance through the promotion of managerial skills and the generation, dissemination and application of knowledge; (3) to recruit, motivate and retain staff in a caring environment; (4) to use ICTs and the virtual classroom as the principal modes of delivery and research for teaching and training; (5) to promote gender equality and equity in student admissions and staff recruitment policies; (6) to enhance the quality of people's lives through new ideas and skills for the sustainable utilization of resources and; (7) to promote quality research as a means of generating new knowledge.

Core Values: honesty, integrity, hard work and a passion for excellence, tempered by self-discipline and caring about others, sensitivity to gender equality and equity and to the needs of the disadvantaged, respect for African culture and devotion to self-sufficiency and professionalism.

Table 41: Faculties and programmes in SETI at Midlands State University

Faculties and schools	Undergraduate Programmes	Postgraduate Programmes
Faculty of Education	• Bachelor of Education Degree in Mathematics • Bachelor of Education Degree in Biology • Bachelor of Education Degree in Food Science and Nutrition • Bachelor of Education Degree in Geography • Bachelor of Education Degree in Computer Science	
Faculty of Natural Resources Management and Agriculture	• Bachelor of Science Horticulture Honours Degree • Bachelor of Science Agronomy Honours Degree • Bachelor of Science Land and Water Resources Management Honours Degree • Bachelor of Science Livestock and Wildlife Management Honours Degree	
Faculty of Science and Technology	• Bachelor of Science Physics Honours Degree • Bachelor of Science Biological Sciences Honours Degree • Bachelor of Science Chemical Technology Honours Degree • Bachelor of Science Chemistry Honours Degree • Bachelor of Science Computer Science Honours Degree • Bachelor of Science Information Systems Honours Degree • Bachelor of Science Food Science and Nutrition Honours Degree • Bachelor of Science Mathematics Honours Degree • Bachelor of Science Surveying and Geomatics • Bachelor of Science Telecommunications Honours Degree	• Master of Science in Ecological Resource Management • Master of Science in Information Systems Management • Master of Science in Food Science and Nutrition Degree

Source: Midlands State University

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

The National University of Science and Technology is a progressive university established by an act of Parliament in 1991. It is located in the city of Bulawayo, south west of Zimbabwe. Using English as the language of instruction, the university fosters an academic community where both staff and students can push back the frontiers of knowledge in science and technology. The university operates as a research centre, with ties to other universities in Africa and beyond..

Vision: to become a world-class centre of excellence in teaching, research, innovation and entrepreneurship for sustainable development

Mission: to contribute positively to the advancement of humanity through the provision of knowledge-based solutions to scientific, technological, economic and social challenges.

Core Values: honesty, integrity, innovativeness, excellence, diligence, intellectual freedom, equity, social and environmental responsibility.

Table 42: Faculties and programmes in SETI at the National University of Science and Technology

Faculties and schools	Undergraduate Programmes	Postgraduate Programmes
Faculty of Sciences	• Bachelor of Science Honours Degree in Applied Biology and Biochemistry • Bachelor of Science Honours Degree in Applied Chemistry • Bachelor of Science Honours Degree in Applied Mathematics • Bachelor of Science Honours Degree in Applied Physics • Bachelor of Science Honours Degree in Computer Science • Bachelor of Science Honours Degree in Environmental Science and Health • Bachelor of Science Honours Degree in Forest Resources and Wildlife • Bachelor of Science Honours Degree in Operations Research and Statistics • Bachelor of Science Honours Degree in Radiography • Bachelor of Science Honours Degree in Sport Science and Coaching	• Master of Science in Computer Science Degree • Master of Science in Applied Chemistry • Master of Science in Microbiology and Biotechnology • Master of Science in Operations Research • Master of Science in Geophysics • Master of Science in Lasers and Applied Optics • Master of Science in Industrial Mathematics • MPhil in Applied Mathematics • PhD in Applied Physics • PhD in Applied Mathematics • PhD in Applied Biology • PhD in Applied Chemistry • PhD in Environmental Sciences • PhD in Computer Science
Faculty of Communication and Information Science	• Bachelor of Science Honours Degree in Library and Information Science	
Faculty of the Built Environment	• Bachelor of Architectural Studies Honours Degree • Bachelor of Architecture • Postgraduate Programmes • Bachelor of Quantity Surveying Honours • Bachelor of Landscape Architecture Honours • Bachelor of Landscape Architecture	• Master of Architecture (to be mounted soon) • Master of Science in Construction Project Management • Master of Urban Design

Faculties and schools	Undergraduate Programmes	Postgraduate Programmes
Faculty of Industrial Technology	• Bachelor of Engineering (Honours) Degree – Chemical Engineering • Bachelor of Engineering (Honours) Degree – Civil and Water Engineering • Bachelor of Engineering (Honours) Degree – Electronic Engineering • Bachelor of Engineering (Honours) Degree – Industrial and Manufacturing Engineering • Bachelor of Textile Technology (Honours) Degree – Textile Technology • Bachelor of Technical Teacher Education Degree	• Master of Engineering Industrial and Manufacturing Engineering in the following options: (a) Manufacturing of Systems and Operations Management and (b) Manufacturing of Exploring and Communication • Master of Philosophy in all engineering disciplines that are offered by the Faculty • Doctor of Philosophy in all engineering disciplines that are offered by the Faculty
Faculty of Medicine	• Bachelor of Medicine and Bachelor Surgery	

Source: National University of Science and Technology

UNIVERSITY OF ZIMBABWE

The University of Zimbabwe is the oldest and finest university in the country; it is involved in teaching and research and offers degrees, diplomas and certificates in the arts, agriculture, law, commerce, education, medicine and veterinary sciences, social studies, science and engineering. All university programmes are accredited by the Zimbabwe Council for Higher Education and other professional bodies in medicine, law, engineering, accountancy, social work and veterinary science.

The rigorous academic standards and high-quality research output demanded of its academic staff make the university's graduates highly sought after in industry, commerce, government departments and other organizations.

The University of Zimbabwe's history began in 1945, when the Rhodesia University Association was created further to the promise of £20,000 for a national university. The following year, the Legislative Assembly of Southern Rhodesia adopted a motion supporting the establishing of a university college to serve the needs of Southern Rhodesia (now Zimbabwe) and neighbouring territories. The Governor of Southern Rhodesia established the Rhodesia University Foundation Fund in 1947. The Legislative Assembly accepted an offer of land in Mount Pleasant from the city of Salisbury (now Harare) for construction of the campus in 1948. Four years later, a bill was enacted for the incorporation and constitution of the university. The first classes began for some 68 students on a temporary site at 147 Baker Avenue (now Nelson Mandela Avenue).

Independently of the initiatives of the authorities and the Legislative Assembly, the Central African Council's commission on higher education, led by Sir Alexander Carr-Saunders, recommended the establishment of a university college to serve Rhodesia (now Zimbabwe) and Nyasaland (now Malawi), its first preference being to integrate this with the Southern Rhodesian initiative.

Construction began on the Mount Pleasant site, funded by grants from the British and Federation of Rhodesia and Nyasaland governments, Anglo-American Corporation, the British South Africa Company, the Rhodesia Selection Trust, the Beit Trust, Ford Foundation and Dulverton Trust. In July 1953, Elizabeth, the Queen Mother, laid the foundation stone.

In 1955, the British government formally adopted the institution, establishing the University College of Rhodesia and Nyasaland by Royal Charter. The college was admitted to the privilege of having a Special Relation with the University of London the following year and, in 1957, all activities were transferred to the Mount Pleasant campus. The following year, the college was granted plots of land upon which the

college farm and the Lake Kariba Research Station were constructed. In 1963, the Medical School opened and was affiliated to the University of Birmingham. After the dissolution of the Federation of Rhodesia and Nyasaland, the University College continued as an independent institution of higher education and research, open to all races.

In 1970, a phased termination of the associations with the Universities of London and Birmingham began, leading to the achievement of university status first as the University of Rhodesia then as the University of Zimbabwe when the country acceded to independence in 1980. In 1981, the first black principal, Prof. Walter Kamba was appointed and, in 1982, the Royal Charter was replaced by an act of Parliament. Student numbers rose from 1 000 in 1980 to 2 000 by 1985 and 12 000 currently.

Vision: to be (and to be recognized as such by others) a leading university working for prosperity, peace and dignity in Zimbabwe and beyond

Mission: to enable its clients and customers to make meaningful contributions to sustainable development in Zimbabwe; to this end, it provides high-quality education, training, research and advisory services to the community on a needs-oriented basis.

Table 43: Faculties and programmes related to SETI at the University of Zimbabwe

Faculties and schools	Undergraduate Programmes	Postgraduate Programmes
Faculty of Agriculture	• Bachelor of Science Honours Degree in Applied Environmental Science • Bachelor of Science Honours Degree in Agriculture(Animal Science, Crop Science and Soil Science) • Bachelor of Science Honours Degree in Agricultural Engineering • Bachelor of Science Honours Degree in Applied Environmental Science	• Master of Science in Soil and Environmental Management • Master of Science in Applied Economics • Master of Science in Animal Science • Master of Science in Agricultural Economics • Master of Science in Biotechnology (in conjunction with Faculty of Science) • Master of Science of Crop Protection • Master of Science in Agrometeorology (in conjunction with Faculty of Science) • Master of Science in Dairy Science and Technology • Master of Philosophy and Doctor of Philosophy degrees in Agriculture
Faculty of Education	• Bachelor of Teacher Education (Practical Subjects) • Bachelor of Education (Science and Mathematics Education) • Bachelor of Education (Teacher Education) • Bachelor of Education (Educational Management) • Bachelor of Education (Technical Education)	• Master of Education (Teacher Education) • Master of Education (Science and Mathematics Education) • Master of Education (Technical Education)
Faculty of Engineering	• Bachelor of Science Honours in Civil Engineering • Bachelor of Science Honours in Electrical Engineering • Bachelor of Science Honours in Mechanical Engineering	• Postgraduate Diploma in Land and Geographical Information Systems • Master of Science in Integrated Water Resources Management – Regional Programme • Master of Science in Water Resources Engineering Management

Faculties and schools	Undergraduate Programmes	Postgraduate Programmes
	• Bachelor of Science Honours in Metallurgical Engineering • Bachelor of Science Honours in Geoinformatics and Surveying • Bachelor of Science Honours in Mining Engineering	• Master of Science in Communications Engineering • Master of Science in Power Engineering • Master of Science in Renewable Energy • Master of Science in Manufacturing Systems and Operations Management (MSOM) • Master of Science in Minerals Production Engineering Management (MPEM) –Regional Programme
College of Health Sciences	• Bachelor of Medicine and Bachelor of Surgery Degrees , 5 years • Bachelor of Dental Surgery, 5 years • Bachelor of Pharmacy Honours, 4 years • Bachelor of Medical Laboratory Sciences Honours Degree, 4 years • Bachelor of Science Honours Degree in Occupational Therapy, 4 years • Bachelor of Science Honours Degree in Physiotherapy, 4 years • Bachelor of Science Honours Degree in Nursing Science, 4 years • Bachelor of Health Education and Promotion, 3 years • Bachelor of Science Honours Degree in Radiography (Diagnostic), 4 years • Bachelor of Science Honours Degree in Radiography (Therapeutic), 4 years • Diploma and Postgraduate Degree Programmes on Offer and Duration • Diploma in Occupational Health and Safety, 1½ years full-time • Diploma in Anaesthetics, 1 year full-time • Diploma in Mental Health, 1 year full-time • Diploma in Ophthalmology, 1 year full-time	• Master of Science Degree in Medicine (Surgery) 4 years part-time • Master of Science Degree in Medicine (Histopathology) 4 years part-time • Master of Science Degree in Medicine (Medicine) 4 years part-time • Master of Science Degree in Medicine (Urology) 5 years part-time • Master of Science Degree in Medicine (Neurosurgery) 5 years part-time • Master of Science Degree in Medicine (Paediatrics) 4 years part-time • Master of Science Degree in Medicine (Obstetrics andGynecology) 4 years part-time • Master of Science Degree in Medicine (Radiotherapy and Oncology) 4 years part-time • Master of Science Degree in Medicine (Anaesthetics) 4 years part-time • Master of Science Degree in Medicine (Ophthalmology), 3 years part-time • Master of Science Degree in Medicine (Psychiatry), 3 years part-time • Master of Science Public Health, 3 years part-time • Master of Science Degree in Biostatistics 2 years full-time • Master of Science Degree in Medical Microbiology, 2 years part-time • Master of Science Degree in Physiotherapy, 2 years part-time • Master of Science Degree in Nursing Science, 1½ years part-time • Master of Science Degree in Clinical Biochemistry 2 yeas part-time • Masters of Science Degree in Clinical Epidemiology, 3 years part-time • Master of Science Degree in Clinical Pharmacology, 2 years full-time

Faculties and schools	Undergraduate Programmes	Postgraduate Programmes
		• M Phil and D Phil degrees across disciplines • Master of Science Degree in Dentistry (Orthodontics) • Master of Science Degree in Public Health (Health Promotion) • Master of Science Degree in Medicine (Orothinolaryngology) • Master of Science Degree in Drug Discovery and Development
Faculty of Science	• Bachelor of Science Honours in Biochemistry • Bachelor of Science with Biochemistry (Being phased out) • Bachelor of Science Honours in Biological Sciences with 4 different specializations in Botany, Genetics and Microbiology, Ecology, Zoology. • Bachelor of Science with Biological Sciences (Being phased out) • Bachelor of Science Honours in Biochemistry • Bachelor of Science with Biochemistry (Being phased out) • Bachelor of Science Honours in Biological Sciences with 4 different specializations in Botany, Genetics and Microbiology, Ecology, Zoology. • Bachelor of Science with Biological Sciences (Being phased out) • Bachelor of Science Special Honours in Biological Sciences • Bachelor of Science Honours in Chemistry • Bachelor of Science with Chemistry (Being phased out) • Bachelor of Science Honours in Computer Science • Bachelor of Science with Computer Science (being phased out) • Bachelor of Science Special Honours in Computer Science • Bachelor of Science Honours Degree in Geology • Bachelor of Science with Geology (being phased out) • Bachelor of Science Honours Degree in Geography • Bachelor of Science Honours in Food Science and Technology • Bachelor of Science Honours in Nutrition Science • Bachelor of Science Honours Degree in Mathematics • Bachelor of Science Honours in Physics • Bachelor of Science Special Honours in Physics • Bachelor of Science with Physics (Being phased out)	• Master of Science Degree in Agricultural Meteorology • Master of Science Degree in Analytical Chemistry • Master of Science Degree in Biotechnology • Master of Science Degree in Chemistry • Master of Science Degree in Computer Science • Master of Science Degree in Environmental Policy and Planning • Master of Science Degree in Exploration Geology • Master of Science Degree in Exploration Geophysics • Master of Science Degree in Geography and Environmental Science • Master of Science Degree in Mathematics • Master of Science Degree in Plant Physiology • Master of Science Degree in Statistics • Master of Science Degree in Tropical Entomology • Master of Science Degree in Tropical Hydrobiology and Fisheries • Master of Science Degree in Tropical Phytopathology • Master of Science Degree in Tropical Resource Ecology

Faculties and schools	Undergraduate Programmes	Postgraduate Programmes
	• Bachelor of Science Honours in Statistics • Bachelor of Science Special Honours in Statistics • Bachelor of Science with Statistics (being phased out)	
Faculty of Veterinary Sciences	• Bachelor of Veterinary Science • Bachelor of Science (Honours) degree in Veterinary Anatomy • Bachelor of Science (Honours) degree in Veterinary Biochemistry • Bachelor of Science (Honours) degree in Veterinary Physiology • Diploma in Veterinary Nursing	• Master of Science in Veterinary Anatomy • Master of Science in Veterinary Biochemistry • Master of Science in Veterinary Physiology • Master of Veterinary Science in Veterinary Pharmacology/Toxicology • Master of Veterinary Science degree in Veterinary Pathology • Master of Veterinary Science degree in Veterinary Parasitology • Master of Veterinary Science degree in Veterinary Microbiology • Master of Science in Tsetse and Trypanosomiasis control • Master of Veterinary Science degree in Ruminant Medicine • Master of Veterinary Science degree in Veterinary Reproduction and Herd Health • Master of Veterinary Science degree in Small Animal Medicine • Master of Veterinary Science or Master of Science degree in Veterinary Epidemiology
Faculty of Social Sciences		• Master of Philosophy • Doctor of Philosophy

Source: University of Zimbabwe

Research institutions related to SETI at the University of Zimbabwe:

University Lake Kariba Research Station

The University Lake Kariba Research Station is an inter-faculty facility of the University of Zimbabwe located on the shores of the artificial Lake Kariba. The station was originally located at Sinamwenda, 140 km west of Kariba Town. It opened in 1962 under the name of Nuffield Research Station, using a £34,000 grant from the Nuffield Foundation, which provided a further £7,500 specifically for terrestrial ecology. The station's main function was to study the ecology and limnology of the new environment and the impact of the lake's creation on the surrounding ecosystems and landscape. During the Zimbabwe War of Liberation, however, it became extremely difficult to work at Sinamwenda. In order to pursue ongoing research on the lake, the station was 'temporarily' moved to its current location, Kasese Bay in Kariba Town.

In 1981, the University of Zimbabwe raised the status of the Nuffield Research Station, then a collaborative research programme in the Division of Biological Sciences, to that of an inter-faculty facility with salaried staff consisting of a director and technical and maintenance staff. It was renamed the University Lake Kariba Research Station, comprising the new Kariba site and the Sinamwenda station. The University of Zimbabwe built the infrastructure at a total cost of Z$0.5 million and funds (SEK 5 million) from the Swedish Agency for Research Cooperation in Developing Countries (SAREC) were used to equip the laboratories.

Under this arrangement, SAREC facilitated the attachment of four Swedish research fellows to the station. These researchers worked on different topics in an attempt to describe the ecology of Lake Kariba. The work conducted under the SAREC grant is summarized in a 1997 publication edited by Jacques Moreau.

Mission: to provide high-quality training and research, thereby contributing to making Zimbabwe part of the global knowledge society (both as a consumer and producer of knowledge) for the benefit of future generations.

Vision: to become a centre of excellence in social, natural and health sciences, so as to promote Zimbabwe as a knowledge-based society, in line with the objectives of the University of Zimbabwe.

Development Technology Centre

The Development Technology Centre is a non-teaching department housed in the Faculty of Agriculture. It is an outreach and extension department concerned with appropriate technology transfer and social welfare.

Institute of Environmental Studies

The Institute of Environmental Studies was established in 1994 as an independent, non-faculty unit within the University of Zimbabwe, in response to a national consensus about the ecological, social and economic consequences of environmental change. It is tasked with providing three services: (a) research and development; (b) education and training and; (c) information, consultancy and networking.

The chief role of the institute is facilitatory, in that it is a front door to harnessing the wide range of resources available throughout the University of Zimbabwe and the country. It facilitates interdisciplinary collaboration in environmental research, education, training and consultancy, thereby providing opportunities to promote integrated approaches to these services. It operates by means of a series of highly decentralized partnerships with departments of the University of Zimbabwe, other universities in developed and developing countries, government institutions and non-governmental organizations in the country, region and beyond. The nature and duration of partnerships are determined by the specific projects undertaken. Although the focus is on Zimbabwe, the institute adopts a regional perspective.

Vision: to become the centre of excellence on the environment in southern Africa

Mission: to contribute to stakeholders' sustainable utilization of natural resources, poverty alleviation and prosperity through education, research, advisory services and networking related to the environment.

Institute of Mining Research

Established in 1969, the Institute of Mining Research is a department within the Faculty of Science at the University of Zimbabwe with the specific mandate of servicing the research needs of mining and related industries. The Ministry of Mines and Mining Development provides funding by way of an annual grant to the institute which is supplemented by income from contract research and externally funded research projects.

The institute's research policy is to work in close liaison with the Chamber of Mines of Zimbabwe to ensure that problems being investigated are of a strong interest to the mining industry. The Executive Committee of the Chamber provides an important link with the institute. The institute focuses on investigations which have a strong scientific content, leading to the development of new ideas and ensure that the research is suited to the requirements of postgraduate research degrees at the university.

The institute has many informal links with universities Internationally and has participated in formal training programmes and projects with the Royal Institute of Technology and Lulea University in Sweden and the University of Guelph in Ontario, Canada, funded by SAREC and the Canadian International Development Research Centre respectively and Arizona University in the USA. The institute is currently demonstrating cleaner gold processing methods through the Global Mercury Project funded by UNIDO.

In the past decade, the Institute has been involved in a number of research projects. These include: (a) the Fogarty Project; (b) the Pelletised Phosphate Blends Project; (c) the Global Mercury Project; (d) the Mining and Minerals Database and; (e) the Collaborative Research Project between the institute, Chamber of Mines and the Platinum Producers' Committee.

The Fogarty Project sought to develop research capacity in institutions related to environment, mining occupational health and safety by running local and regional training workshops, funding research and the acquisition of analytical and other important equipment. The project, which was funded by Fogarty International at University of Arizona, also involved collaboration with the Zambia School of Mines at the University of Zambia. Although the Zimbabwean chapter ended officially in 2006, its activities were extended to 2008.

The Pelletised Phosphate Blends Project saw the production of an indigenous fertilizer technology that utilizes Dorowa phosphate rock and triple superphosphate to produce fertilizer pellets that are used to fortify cattle manure. The fortified manure improves soil fertility and strength and works for four years once applied to a piece of land. Zimbabwe is among the leading countries in the world for this area of agrogeology. The Institute has already patented the pelletized phosphate blends technology and is now looking to commercializing the technology.

The Global Mercury Project is an initiative of the United Nations to promote safer and cleaner practices in artisanal mining communities where mercury is used to process gold. At the Institute of Mining Research, the project sought to create awareness among artisanal miners in the Kadoma-Chakari area of the dangers of using mercury and introduce them to a cleaner, safer and more accessible technology in the form of retorts. The project ended in 2008.

The Database Project began in 2006 in conjunction with the Raw Materials Group (Stockholm, Sweden). The project was limited to a few data items such as the names of mines by mineral type, location, mine ownership, operational status, type of operation (whether underground or open cast), together with contact details and mine production figures (time series). In 2007, these data items were extended to include reserve estimates, ore grades, recoveries and basic information on exports and imports, as well as an update of previous data. In 2007, a rudimentary specific database for limestone was put together, limited to deposits, location, ownership and operational history. The project is constrained by lack of funding.

In August 2012, the Chamber of Mines of Zimbabwe, Institute of Mining Research (University of Zimbabwe) and the Platinum Producers Committee signed a Memorandum of Agreement which gave rise to the establishment of a collaborative research project. The project's main aim was to provide factual information about Zimbabwe's platinum industry for policy formulation, to foster sustainable development of the platinum mining industry. Five papers summarizing the project's research findings were due to be presented and discussed at a conference in 2013.

Over the past half-century, hundreds of publications, including scientific reports, have been produced by the Institute of Mining Research and are available in its library. A couple of mines were opened as a result of direct research by the Institute. Beneficiation projects initiated at the institute have benefited mining corporations and small-scale miners.

University of Zimbabwe School of Technology

The University of Zimbabwe School of Technology offers training in ICTs. The school offers applied information technology courses at certificate, diploma and degree levels. It i unique in that it offers skills-based, hands-on training with continual assessment, specializing in hardware, software and network engineering. The school is located in the Department of Mathematics at the University of Zimbabwe and currently has 13 full-time academic, technical and clerical staff members.

The ICT profession is going through numerous changes with new technologies emerging all the time. Consequently ICT business requirements are also constantly changing. The School of Technology has forged meaningful relationships with its industrial partners so as to keep abreast of ever-changing technologies and business requirements.

The School of Technology is committed to ensuring that its curriculum meets local, regional and international business requirements. This is particularly reflected in the school's emphasis on training in free and open source software (FOSS), as it is in demand in the ICT marketplace. It plans to work with a number of organizations which contribute to FOSS projects in order to turn the school into a FOSS Certification Centre

WOMEN'S UNIVERSITY IN AFRICA

The need to increase opportunities for women in Africa to access university led to the establishment of the private Women's University in Africa in 2002.

With a student enrolment policy of 80% women and 20% men, the Women's University in Africa aims to address gender disparity and foster equity in accessing tertiary education and to develop knowledge and skills in areas of vital importance to women. The university endeavours to enhance women's capacity and confidence to enable them to fulfil leadership, social, political and economic roles and also make informed decisions about themselves in relation to women's rights. In addition, the university aims to equip African women with skills to face and tackle challenges in their respective countries and in the global arena. The university is supported by student fees and donors from around the globe.

Table 44: Faculties and programmes in SETI at the Women's University in Africa in Zimbabwe

Faculty of Agriculture	Diploma in Environmental Management
	B.Sc. (Hon.) in Agribusiness Management
	B.Sc. (Hon.) in Animal Science
	B.Sc. (Hon.) in Horticulture
Faculty of Management and Entrepreneurial Development Studies	Diploma in Project Planning and Management
	Executive Diploma In Management
	B.Sc. (Hon.) in Information Systems
	B.Sc. (Hon.) in Management and Entrepreneurial Development Studies
	Master of Science in Strategic Marketing
Faculty of Social Sciences and Gender Development Studies	B.Sc. (Hon.) in Psychology
	B.Sc. (Hon.) in Sociology and Gender Development Studies
	B.Sc. (Hon.) in Women's and Gender Studies
	Master of Science in Development Studies

Source: Women's University in Africa

ZIMBABWE OPEN UNIVERSITY

The Zimbabwe Open University offers open and distance learning. It started off as the Centre for Distance Education in 1993, established by the University of Zimbabwe in the Department of Education Administration. In 1996, the centre became the University College of Distance Education headed by Prof. Graham Hill. In 1999, through an act of Parliament, the college became a fully fledged university headed by Prof. Peter Nzvimbo. Dr Primrose Kurasha made history by becoming the first female Vice Chancellor in Zimbabwe, heading the Zimbabwe Open University.

In 1993, the Centre for Distance Education only offered one programme, the Bachelor of Education degree, for 652 students. Today, it has more than 30 degree programmes.

In order to cater for students throughout Zimbabwe, the university has a highly decentralized structure with 10 regional centres in all the provinces. Programmes are delivered through the print module, weekend tutorials, DVDs and other alternative strategies. Nearly 21 000 students have graduated in the past six years; they can be found in every sector of the economy.

Mission: to empower people through lifelong learning, thereby enabling them to realize their full potential in an affordable and flexible manner

Vision: to become a world-class open and distance learning university.

Table 45: Faculties and programmes in SETI at the Zimbabwe Open University

	Undergraduate Programmes
Faculty of Science and Technology	Bachelor of Science Agricultural Management (4 Years)
	Bachelor of Science In Nursing Sciences (4 Years)
	Bachelor of Science in Physical Education and Sport (4 Years)
	Bachelor of Science Special Honours in Physical Education and Sport (1 Year)
	Bachelor of Science in Mathematics & Statistics (4 years)
	Bachelor of Science Honours in Geography and Environmental Studies (4 years)

Source: Zimbabwe Open University

AGRICULTURAL COLLEGES

Agricultural training colleges are located in different parts of Zimbabwe. Diploma-granting colleges include Chibero, Gwebi, Esigodini, Mazowe and Mlezu, with a total student capacity of 790.

Certificate-granting colleges include Kushinga Pikelela, Magamba, Chaminuka, Mashayamombe, Mashagashe, Kaguvi and Rupangwana, with a total student capacity of 1 185. A high school certificate-holding student can enrol for certificate-level or diploma-level training in agriculture.

The certificate level of training can subsequently qualify the student to enrol in a higher, diploma level of training. This often includes a period of on-farm training, usually lasting one year. Upon completion of their diploma, students are apt to be employed as a farm staff trainer or manager.

Agricultural colleges have been designed to offer training in a variety of fields. For example, Mazowe College offers training in veterinary sciences, whereas Rupangwana College offers training in plantation crops (forestry, orchard plants, etc.).

The training provided by both the agricultural colleges and agricultural degree-granting universities has provided the country with skilled professionals who have, in normal years, obtained very good agricultural productivity. There have also been years of poor agricultural productivity. One cause has been poor rainfall, which is becoming more frequent apparently as a consequence of the climate change phenomenon being experienced globally. The second factor behind years of poor productivity has been the frequent irregular availability of agricultural inputs (seed and fertilizers). These agricultural skills are normally used by commercial farmers and are now being frequently passed on to villages. These two farming systems –commercial and small-scale – differ largely in the scale of operation and mechanization.

PRIVATE INSTITUTIONS INVOLVED IN RESEARCH AND INNOVATION

AFRICAN INSTITUTE OF BIOMEDICAL SCIENCE AND TECHNOLOGY

This institute was founded in 2002 to promote drug discovery and development in Zimbabwe and Africa at large. To achieve its objective of promoting pharmaceutical sciences and optimal clinical use of medicines in African populations, the institute has set up a research and advanced biomedical training institute. Notable findings from its research include:

a. identification of the genetic basis for the reduced capacity of African populations to metabolize and eliminate some drugs which are substrates of the CYP2D6 enzyme. These findings are triggering further clinical studies to evaluate the clinical implications of such genetic variability with the aim of revising the dosage of some drugs given to African patients, compared to the dosage recommended for European patients and;

b. establishment of the first comprehensive biobank and pharmacogenetics database of African populations. This bank of samples (blood and DNA) from 10 ethnic groups across Africa is being used to explore the variability of African populations with respect to susceptibility to infectious diseases, disease progression and response to medication. This is the first effort to ensure that pharmaceutical companies take into account the genetic variability of African populations. One finding arising from this study already indicates a need to revise the dosage of one anti-retroviral drug, efavirenz, when given to Africans; the study showed that up to 20% of HIV/AIDS patients would require only half (300 mg) of the current recommended dose (600 mg) in Caucasian patients. If extensive clinical trials confirm this, it can result in safe and cheaper use of this narrow therapeutic index drug in Zimbabwe.

The institute also trains postgraduate students in drug discovery and development at MSc and PhD levels. Owing to its expertise in industrial drug metabolism and pharmacokinetics, the institute has been selected by the World Health Organization (WHO) as a centre of excellence in Africa. Within this role, it is carrying out drug ADMET profiling for relevant WHO projects and those of other researchers in Africa.

AFRICAN CENTRE FOR FERTILIZER DEVELOPMENT

The objectives of the centre are to: (1) serve as a regional international centre to achieve technology transfer for improved fertilizer production in Africa; (2) conduct and support research, develop, promote, and demonstrate the role of fertilizers in improved agriculture and fertilizer management; (3) encourage and provide support to the African fertilizer sector; (4) develop co-operation and collaborative projects with other national, regional and international institutes concerning the adaptation, testing and demonstration of improved fertilizers and fertilizer knowledge and; (5) conduct, foster and support training in all aspects of the fertilizer sector and other fertilizer-related activities.

BIOMEDICAL RESEARCH AND TRAINING INSTITUTE

The Biomedical Research and Training Institute is a regional not for profit organization based in Harare. It serves the SADC countries and the rest of Africa. In 2009, the institute acquired affiliate status with the University of Zimbabwe's Institute of Continuing Health Education in the College of Health Sciences.

The institute is a recognized centre for international collaborative research and training with a focus on HIV/AIDS, tuberculosis and malaria and has successfully lobbied for support for these activities with a number of non-governmental and governmental organizations.

Over the past decade, the institute has responded to public health and development issues pertaining to HIV/AIDS in Zimbabwe and SADC in general with numerous research projects, programme implementation and capacity-building activities.

Most of the projects administered by the institute are funded by international agencies through competitive grant applications. The institute has collaborated with the Ministry of Health and Child Care in particular on several studies and has been commissioned by various local and international agencies to conduct research.

Over the years, the institute has published scientific reports and research articles in international journals and disseminated research findings at various local and international fora.

EMPRETEC ZIMBABWE

Empretec Zimbabwe was registered as a trust in 1997. The objective of Empretec is to build and nurture a high-quality, growth-oriented community of internationally recognized entrepreneurs in a commercially viable manner.

Empretec is an integrated capacity-building programme of UNCTAD providing promising entrepreneurs with a support structure to help them build innovative and internationally competitive small and medium-sized enterprises (SME).

Empretec has trained over 15 000 entrepreneurs, at least 85% of whom have proceeded to set up or expand existing businesses, 35% of which are export-oriented. Some 49% are women and 40% were previously in professional positions. Empretec has created over 20 000 jobs and fostered an entrepreneurial culture. It is considered a main player in the development of the SME sector.

Source: www.empretec.co.zw

FORESTRY INDUSTRIES TRAINING CENTRE

The Forest Industries Training Centre offers in-depth training in primary wood processing and saw doctoring. Situated in the Christmas Pass area of Mutare in the heart of the timber industry, the centre is the only one of its kind in Zimbabwe and perhaps in the whole SADC region. The institution was established as a joint venture between the Government of Zimbabwe, the Government of Italy and the United Nations Food and Agricultural Organization in 1985. Currently, the centre is a national project run by the Forestry Commission of Zimbabwe, which is a state authority involved in both commercial and social activities related to forestry.

With the realization that national resources are dwindling fast, it is felt that one way of minimizing the depletion is to use the country's forests sustainably. By training skilled personnel for the mechanical wood industry, the centre is contributing to this effort.

Source: www.fitc.org.zw

INTERNATIONAL CROPS RESEARCH INSTITUTE FOR SEMI- ARID TROPICS

The International Crops Research Institute for Semi- Arid Tropics (ICRISAT) is a non-profit, non-political organization that conducts agricultural research for development in the dry lands of Asia and sub-Saharan Africa. Covering 6.5 million km^2 of land in 55 countries, the semi-arid or dry land tropics has a population of over 2 billion, 644 million of whom are the poorest of the poor.

ICRISAT and its partners help empower these poor people to overcome poverty, hunger and a degraded environment through better agriculture. ICRISAT is headquartered in Hyderabad, Andhra Pradesh, in India, with two regional hubs (Nairobi and Bamako) and country offices in Niger, Zimbabwe, Malawi and Mozambique. ICRISAT conducts research on five highly nutritious drought-tolerant crops: chickpea, pigeonpea, pearl millet, sorghum and groundnut.

Source: www.icrisat.org

BOX 16 – AGRICULTURAL RESEARCH TRUST

The *Medium Term Plan* recognizes that Zimbabwe needs to focus more on applied/adaptive, developmental and strategic agricultural research that addresses national, sectorial and local farmer problems and needs. It proposes some measures for improving crop production and food security, such as by strengthening national agricultural research through training, the provision of materials and equipment, and better conditions for research scientist and extension officers.

Three main non-profit agencies conduct agricultural research in Zimbabwe. These are the Agricultural Research Trust, which has been conducting both crop and livestock research since 1981; African Institute for Agrarian Studies (est. 2003) and; the Ruzivo Trust (est. 2004), which conducts research on natural resources and socio-economics.

The Agricultural Research Trust

The Agricultural Research Trust is the oldest and biggest non-profit organization involved in agricultural and livestock research in Zimbabwe. It was established in 1981 by the Commercial Oilseeds Producers' Association and Commercial Grain Producers' Association, with subsequent financial support from the cereal and cattle producer associations. Initially, the Agricultural Research Trust relied on financial support from member commodity associations but, by 1993, had become totally independent and self-financing. Today, this non-profit institution charges commercial producers for all its services on a full cost-recovery basis, making it a fully independent agricultural research and extension institute with a financial budget designed to cover recurring operational overheads, planned capital replacement and capital development costs. In order to encourage research, fees have been reduced to a minimum, generating a failure at times to maintain its capital replacement and some development programmes.

The Agricultural Research Trust's objectives, as laid down in the original Trust Deed, are *inter alia* to: (1) research row and horticultural crops and provide land, management inputs and skills for the benefit of the commercial farmers of Zimbabwe; (2) provide contract research services; (3) demonstrate veldt and pasture management, commercial row crop, horticulture, cattle and pig production as practiced by large scale producers; (4) demonstrate and test agricultural machinery and farm management systems; (5) disseminate agricultural knowledge through publications, reports, discussions, seminars, field days and visitor programmes and; (6) provide an on-call extension service.

In the past, there was close formal liaison between the staff of the trust and the technical team of the Farmers Union who were responsible for generating research projects in consultation with their farmer members through the Commodity Executives and Commodity Council. This liaison still exists but the trust is increasingly undertaking research projects specifically for agricultural trade, service providers and interested farmers, thereby favouring independently funded research that is client oriented.

The trust employs one director and five professional and technical officers supported by two technicians and 120 junior staff who are mostly housed on the Trust's farm. The farm occupies 250 hectares of arable land 18 km due north of Harare. It comprises a special 67-hectare field laboratory used for commercial crop production that is divided into 100 rectangular plots; these form the basis of the on-station research programme. There is a small area of coffee set aside for disease research and a small plantation of *Jatropha curcas* for demonstration purposes. Most of the research done each year concerns annual crop variety improvement, with some agronomy and machinery evaluation.

The Agricultural Research Trust, in co-operation with willing farmers, runs an off-station research programme at some 30 sites around the country for both summer and winter investigations. It promotes practical training of undergraduate students of university and agricultural colleges

and hosts university and school visits throughout the year. It also provides extension services to clients and government agricultural personnel and organizes joint road shows and field days with farmers' associations on prevailing issues.

By 2000, the Agricultural Research Trust was one of the best developed institutes of its kind in Africa, if not in the world. This shows how STI can be further developed through private finance, even in poor countries like Zimbabwe, as it addresses real needs of developing societies.

An institutional export model for the agricultural research non-profit sector in Zambia

In the face of the general trend towards a drop in funding for agricultural R&D by the government and development agents in SADC countries, private funding institutions like the Agricultural Research Trust are taking on a more important role in linking the actors of agricultural R&D: public authorities, universities and farmers.

In Zambia, the Golden Valley Agricultural Research Trust (GART) is trying to compensate for the 30% decline in the staffing table of the country's main agricultural R&D performer, the Zambian Agricultural Research Institute (ZARI), which counted 120 professional staff, 120 technicians and 340 support staff in 2010. The Agricultural Research Trust in Zimbabwe can learn from the experience of the Golden Valley Agricultural Trust. Moreover, it should be easy to reinforce ties between the two trusts, as the Regional Director of the International Centre for Research in Semi-Arid Tropics (ICRISAT) in Bulawayo, Zimbabwe, is a member of the Board of Trustees of the Golden Valley Agricultural Trust.

The Zambian Agricultural Research Institute is in a dire situation, with many laboratories still using equipment from the 1970s, when it functions at all. In contrast to other countries, very little donor money has apparently been forthcoming, leaving the Zambian Agricultural Research Institute to rely on the government for 90–95% of its funding. Usually, less than half of the formal budget of approximately US$ 600,000–800,000 is actually available.

The Golden Valley Agricultural Research Trust and Zambian Agricultural Research Institute also have complementary research niches, with the latter not being involved in agricultural engineering technology. One particular problem is that seed companies in Zambia do not use particular seed strains for commercial purposes even though they could, apparently because Zambians are not sufficiently used to working with fairly common intellectual property clauses, in this case based on plant breeders' rights, the subject of current discussions in Zambia in a committee chaired by the director of the Golden Valley Agricultural Trust.

The Golden Valley Agricultural Research Trust was created in 1993 by the Government of the Republic of Zambia, in partnership with the Zambia National Farmers Union, as a substantially self-sustaining and autonomous public private partnership and as part and parcel of the National Agricultural Research and Extension System. The broad objectives of the Golden Valley Agricultural Research Trust translate into two science and technology programmes. Its mission is to help optimize the production, commerce and trade in crops, milk, chicken, goats and, wherever possible, their by-products and to promote income security among the target beneficiaries through Integrated Agricultural Research for Development (IAR4D) programmes for market-oriented small-, medium- and large-scale farmers. The Golden Valley Agricultural Research Trust shares society's bigger worries and pays special attention to women and youth, especially those affected or infected by HIV/AIDS.

The Golden Valley Agricultural Research Trust employs around 100 people and relies for finance on the government (which provided the land, buildings and money to refurbish the buildings and equipment), on international donors which contribute through the Farmers' Association and,

for 40% of its income, on commercial farming and contract research. The balance is financed by the donor community, currently principally the Governments of Norway and Sweden, as well as the United Nations Common Fund for Commodities. The Government of the Republic of Zambia contributes less than 5% of the Golden Valley Agricultural Research Trust's annual budget.

The distinguishing characteristic of the Golden Valley Agricultural Research Trust, compared to the Zambian Agricultural Research Institute for instance, is the combination of commercial farming with R&D and dissemination and training. This complements the Zambian Agricultural Research Institute, whose role is essential in maintaining infrastructure (the laboratories) for the more specialized agricultural research (soil physics, microbiology, biotechnology etc.) and seed bank. The Golden Valley Agricultural Research Trust plays a key role in reaching out to farmers with its own results and those of others, and by training personnel in the Extensions Services of the Ministry of Agriculture. In this endeavour designed to transfer knowledge to users, farmers, officials and students, the Golden Valley Agricultural Research Trust has also developed solid relations with the University of Zambia. There are three joint appointments, allowing three teachers or professors to work two days a week at the Golden Valley Agricultural Research Trust. Five to six students also have internships at the trust. In addition, some 20 students get the practical training they cannot obtain from the university. New crops (such as the guar for dry soils) and biofuels are key areas for the future R&D agenda.

The Golden Valley Agricultural Research Trust has relations with other international centres, as it believes that Zambian scientists need to be exposed to international environments. Although essentially a Zambian Institution, the trust is implementing professional programmes and has associate staff in Botswana, Lesotho and Namibia.

In terms of facilities, the trust has a research farm of 1 306 hectares called Golden Valley, a commercial farm in Chaloshi (1 340 hectares) and a livestock development centre of 9 070 hectares that includes a commercial ranch.

The Golden Valley Agricultural Research Trust is governed by an independent Board of Trustees. The board meets regularly to approve work plans and budgets, review progress and set policy direction. The board also operates through a system of technical and specialist committees: (1) Finance, Audit and Administration Committee; (2) Crop Research and Extension Committee and; (3) Livestock Research and Extension Committee. The technical committees (2) and (3) above have wider representation from both the private sector and government, as well as among the ultimate beneficiaries.

The composition of the Board of Trustees is based on three constituencies identified at the trust's inception. These are:

- Government of the Republic of Zambia: the representatives are the Minister of Agriculture and Cooperatives, the Director of Research and Specialist Services of the same ministry and the Permanent Secretary of the Ministry of Tourism, Environment and Natural Resources;
- Zambia National Farmers' Union;
- International Agricultural Research Centres: the Regional Director of the International Centre for Research in Semi-Arid Tropics (ICRISAT) in Bulawayo, Zimbabwe.

The accounts of the Audit Committee are validated each year by external auditors; these audits are produced for consideration and approval by the Board of Trustees.

Juliana Chaves-Chaparro, Associated Project Officer, UNESCO

Inventory of Zimbabwe's legal framework for SETI

The legal framework represents a collection of legal devices or legal instruments which embody a given policy, or parts of it, in the form of a law, decree or policy regulation. Formal agreements, contracts and international SETI co-operation treaties may also be included in this category. A legal device goes one step beyond a policy by stipulating obligations, rights, rewards and penalties connected with its observance. The SETI legal framework of the Republic of Zimbabwe is presented hereafter.

NATIONAL LAWS AND ACTS

Acts pertaining to research and innovation

TOBACCO RESEARCH ACT

Enacted date and amendment date and section: Acts 1/1955 (Federal), 17/1956 (Federal), 15/1957 (Federal), 57/1972 (s. 34), 39/1973 (ss. 48 and 53), 61/1973 (s. 11), 29/1990; R.G.N. 630/1963; S.I. 566/1979

Description: makes provision for the direction and maintenance of research in connection with tobacco (see Box 9).

Link: www.law.co.zw/downloads/statutes/18/Tobacco Research Act.pdf

SCIENTIFIC EXPERIMENTS ON ANIMALS ACT

*Enacted date:*Act 17/1963 (Federal); R.G.N. 796/1963

Description: makes provisions with respect to the performance of painful experiments on living vertebrate animals for the purposes of scientific research and higher education.

Link: www.law.co.zw/downloads/statutes/19/Scientific Experiments On Animals Act.pdf

AGRICULTURAL RESEARCH ACT

Enacted date and amendment date and section: Acts 31/1970, 18/1975; S.I. 566/1979

Description: provides for the establishment of the Agricultural Research Council; stipulates that the functions and duties of the said council shall be to keep under review and promote all aspects of agricultural research in Zimbabwe and, in certain circumstances, to carry out agricultural research; confers powers on the said council and makes provision for the financial affairs thereof.

Link: www.parlzim.gov.zw/attachments/article/104/AGRICULTURAL_RESEARCH_ACT_18_05.pdf

TOBACCO MARKETING AND LEVY ACT

Enacted date and amendment date and section: Acts 32/1977, 5/1988, 29/1990, 4/1991, 1/1994, 4/1994, 15/1994, 5/1997, 22/2001 (s.4); S.I. 566/1979

Description: provides for the control and regulation of the tobacco industry in Zimbabwe, the promotion of the export of tobacco and the imposition of a levy on tobacco grown or sold in Zimbabwe; controls the use of agricultural remedies on tobacco and tobacco plants or lands; provides for the establishment of the Tobacco Industry and Marketing Board and prescribes its functions and powers [Date of commencement: 1 January 1978]. Also regulates the funding mechanisms for the Tobacco Research Board (see Box 9).

Link: www.law.co.zw/downloads/statutes/18/Tobacco Marketing And Levy Act.pdf

RESEARCH ACT

Enacted date and Amendments dates: Acts 5/1986, 2/1988, 18/1989 (s. 40, s. 43), 11/1991 (s. 29), 2/1998, 22/2001

Description: establishes the Research Council of Zimbabwe and confers on the council functions and powers relating to the promotion, direction, supervision and co-ordination of research; provides for the establishment of research councils and research institutes and for the control of such research councils and research institutes by the Research Council of Zimbabwe; provides for the control of research conducted by bodies or persons in terms of any act; provides for the registration of foreign researchers.

Link: www.law.co.zw/downloads/statutes/10/Research Act.pdf

MANPOWER PLANNING AND DEVELOPMENT ACT

Enacted date and amendment date and section: Act 24/1994, 22/2001 (s. 4), 1/2001

Description: provides for the establishment, maintenance and operation of technical or vocational institutions, universities, teachers colleges and vocational training schemes; provides for, and promotes, the research, planning and development of human resources; provides for the establishment and functions of a National Manpower Advisory Council; provides for the training of apprentices and the certification of skilled workers; provides for the continued existence of the Zimbabwe Manpower Development Fund and for the imposition of levies to finance manpower development and for other purposes.

Link: www.law.co.zw/downloads/statutes/28/Manpower Planning And Development Act.pdf

RADIATION PROTECTION ACT

Enacted date and amendment date and section: Act 5/2004

Description: establishes a Radiation Protection Authority and confers powers and functions on such an authority in relation to protecting the public and workers from dangers resulting from the use or abuse of equipment, devices or materials capable of producing ionizing radiation.

Link: www.rpaz.co.zw/Downloads/Radiation Protection Act.pdf

NATIONAL BIOTECHNOLOGY AUTHORITY ACT

Enacted date and amendment date and section: Act 3/2006, 5/2011 (s. 8)

Description: enables Zimbabwe to take advantage of the opportunities presented by breakthroughs in biotechnology while minimizing the potential risks.

Link: www.vertic.org/media/National%20Legislation/Zimbabwe/ZW_National_Biotechnology_Authority_Act.pdf

Acts pertaining to intellectual property rights

SEEDS ACT

Enacted date and amendment date and section: Acts 40/1965, 53/1973 (s. 49), 39/1979, 29/1981, 11/2001

Description: provides for the registration of sellers of seed and seed testing laboratories; regulates the importation, exportation and sale of seed; provides for the testing, certification and inspection of seed.

Link: www.law.co.zw/downloads/statutes/19/Seeds Act.pdf

COPYRIGHT ACT

Enacted date and amendment date and section: Acts 60/1966, 29/1969, 17/1971 (s. 59), 32/1979 (s. 8), 29/1981; R.G.N. 1340/1973

Description: makes provision in respect of copyright and related matters.

INDUSTRIAL DESIGNS ACT

Enacted date and amendment date and section: Acts 17/1971, 39/1973, 15/1981, 29/1981, 40/1983, 12/1986 (s. 12), 11/1991 (s. 16), 20/1994 (s. 6), 22/2001, 25/2001

Description: consolidates and amends the law relating to the registration of industrial designs.

Link: www.law.co.zw/downloads/statutes/26/Industrial Designs Act.pdf

PATENTS ACT

Enacted date and amendment date and section: Acts 26/1971, 39/1973 (ss. 39 and 52), 42/1976 (s. 15), 39/1979, 15/1981, 29/1981, 41/1983, 12/1986 (s. 13), 11/1991 (s. 17), 20/1994 (s. 7), 22/2001, 9/2002, 14/2002

Description: consolidates and amends the law relating to patents.

Link: www.law.co.zw/downloads/statutes/26/Patents Act.pdf

PLANT BREEDERS RIGHTS ACT

Enacted date and amendment date and section: Acts 53/1973, 39/1979, 11/2001, 22/2001

Description: provides for the registration of plant breeders rights in respect of certain plant varieties and the protection of the rights of persons who are registered as the holders of such rights.

Link: www.law.co.zw/downloads/statutes/18/Plant Breeders Rights Act.pdf

TRADEMARKS ACT

Enacted date and amendment date and section: Acts 2/1974, 44/1975 (s. 14), 15/1981, 29/1981, 11/1991 (s. 18), 20/1994 (s. 8), 22/2001; R.G.N 1135/1975

Description: consolidates and amends the law relating to the registration of trademarks and certification marks; provides for the registration and control of the practice of trade mark agents; protects registered trademarks against forgery. The Trade Marks Amendment Act gives retroactive protection to all trade mark registrations that designated Zimbabwe under ARIPO's protocol system. It also widens the scope of the definition of a 'mark', provides for registration of collective marks, offers broader protection and allows for the award of punitive damages in respect of flagrant infringements.

Link: www.law.co.zw/downloads/statutes/26/Trademarks Act.pdf

COPYRIGHT AND NEIGHBOURING RIGHTS ACT

Enacted date and amendment date and section: Act 11/2000, 22/2001 (s. 4), 32/2004

Description: provides for copyright and neighbouring rights.

Link: www.law.co.zw/downloads/statutes/26/Copyright And Neighbouring Rights Act.pdf

INTEGRATED CIRCUIT LAYOUT-DESIGNS ACT

Enacted date and amendment date and section: Acts 18/2001

Description: provides for the registration of layout-designs of integrated circuits and for the protection of registered layout-designs.

Link: www.law.co.zw/downloads/statutes/26/Integrated Circuit Layout-Designs Act.pdf

CONSTITUTION OF ZIMBABWE AMENDMENT (NO.20) ACT

Enacted date and amendment date and section: 22 May 2013; 20/2013

Description: repeals the Constitution of Zimbabwe of 1979; sets out the new constitution in the schedule to the act. The new constitution does not contain specific provisions on intellectual property. However, Chapter 2, Section 33 states that 'The State must take measures to preserve, protect and promote indigenous knowledge systems, including knowledge of the medicinal and other properties of animal and plant life possessed local communities and people'. Furthermore, Chapter 2, Part 4, Section 71 defines property rights in general and provides protection from deprivation of property.

Link: www.parlzim.gov.zw/attachments/article/56/constitution.pdf

Acts pertaining to environmental management and protection

FORESTRY ACT

Enacted date and amendment date: Acts 37/1949, 28/1953, 3/1954, 12/1954, 43/1954, 14/1955, 19/1959, 8/1960,26/1961, 14/1962 (s. 2), 24/1962 (s. 2), 28/1963, 47/1963 (s. 62), 19/1965, 53/1967,75/1971, 12/1972, 39/1973 (s. 53), 46/1973 (s. 144), 54/1973 (s. 31) 9/1975, 42/1976(s. 8), 48/1976, 22/1977, 10/1978, 5/1979, 40/1981, 20/1982, 31/1983, 8/1988,17/1989, 18/1989 (s. 16), 29/1990 11/1991(s. 13),8/1999,22/2001,13/2002;R. G.N.s153/1963, 214/1964, 216/1970, 217/1970, 313/1970, 365/1970, 1181/1971,923/1972; S.I.'s 468/1979, 675/1979, 662/1980, 193/1981, 489/1981, 307/1982,364/1982, 530/1982, 669/1982, 255/1983, 455/1983, 635/1983, 647/1983, 80/1984,117/1984, 362/1984, 86/1985, 44/1986, 283/1986, 322/1986, 156/1987, 296/1987, 88/1988, 115/1988, 206/1990.

Description: establishes a commission for the administration, control and management of state forests; provides for the transfer of certain assets belonging to the government to the said commission; provides for the setting aside of state forests and for the protection of private forests, trees and forest produce; establishes a Mining Timber Permit Board to control the cutting and taking of timber for mining purposes; provides for the conservation of timber resources and the compulsory afforestation of private land; regulates and controls trade in forest produce, including the use of trade names and marks in connection with forest produce; regulates and controls the burning of vegetation.

Link: www.law.co.zw/downloads/statutes/19/Forest Act.pdf

MINES AND MINERALS ACT

Enacted date and amendment date and section: Acts 38/1961, 24/1962 (s. 2), 18/1963 (s. 24), 19/1963 (s. 12), 7/1964, 22/1964 (s.54), 10/1966, 9/1967 (s. 17), 30/1968 (s. 38), 17/1969, 61/1969, 80/1971 (s. 33),39/1973 (s. 52), 46/1973, 15/1975, 22/1976, 41/1976, 42/1976 (s. 10), 48/1976,7/1978, 8/1978, 41/1978 (s. 12), 15/1979, 32/1979, 37/1979, 29/1981, 20/1982,26/1987, 8/1988, 9/1990, 14/1991, 3/1992, 22/1992 (s. 9), 10/1993, 10/1994, 9/1997(s. 10), 12/1997 (s. 15), 22/2001; R.G.N.s 153/1963, 801/1963, 214/1964, 386/1964,216/1970, 217/1970, 313/1970, 88/1974, 1135/1975

Description: consolidates and amends the law relating to mines and minerals.

Link: www.law.co.zw/downloads/statutes/18/Mines And Minerals Act.pdf

ATMOSPHERIC POLLUTION PREVENTION ACT

Enacted date and amendment date and section: Acts 33/1971, 25/1973, 26/1974, 42/1976, (s. 34), 12/1977, 39/1979, 8/1988, 12/1997(s. 14), 22/2001

Description: provides for the prevention and control of atmospheric pollution; provides for the establishment of an Air Pollution Advisory Board and confers functions and powers on such board.

Link: www.parlzim.gov.zw/attachments/article/106/ATMOSPHERIC_POLLUTION_PREVENTION_ACT_20_03.pdf

PARKS AND WILD LIFE ACT

Enacted date and amendment date and section: Acts 14/1975, 42/1976 (s. 39), 48/1976 (s. 82), 4/1977, 22/1977, 19/1978, 5/1979,4/1981 (s. 19), 46/1981, 20/1982 (s.19 and Part XXVI), 31/1983, 11/1984, 35/1985,8/1988 (s. 164), 1/1990, 11/1991 (s. 24), 22/1992 (s. 14); 19/2001; 22/2001; 13/2002.R.G.Ns 1135/1975, 52/1977, 126/1979, 294/1979, 265/1979, 294/1979, 748/1979;S.Is 675/1979, 632/1980, 640/1980, 704/1980, 773/1980, 781/1980, 786/1980,139/1981, 140/1981, 181/1981, 183/1981, 639/1981, 860/1981, 139/1982, 140/1982,337/1983, 454/1983, 123/1991

Description: establishes a Parks and Wild Life Board and confer functions and imposes duties on the said board; provides for the establishment of national parks, botanical reserves, botanical gardens, sanctuaries, safari areas and recreational parks; makes provisions for the preservation, conservation, propagation or control of the wildlife, fish and plants of Zimbabwe and the protection of the natural landscape and scenery; confers privileges on owners or occupiers of alienated land as custodians of wildlife, fish and plants; grants certain powers to intensive conservation area committees.

Link: www.law.co.zw/downloads/statutes/20/Parks And Wild Life Act.pdf

ZIMBABWE MINING DEVELOPMENT CORPORATION ACT

Enacted date and amendment date and section: Acts 31/1982, 29/1990 (s. 22), 3/1991, 22/2001

Description: establishes the Zimbabwe Mining Development Corporation and provide for the functions, powers and duties thereof; provides for the constitution, functions, powers and duties of the Mining Development Board; regulates the financial affairs of the Zimbabwe Mining Development Corporation.

ZIMBABWE NATIONAL WATER AUTHORITY ACT

Enacted date and amendment date and section: Acts 11/1998, 22/2001, 14/2002. Modified by S.1. 430/1999

Description: establishes the Zimbabwe National Water Authority and provides for its functions; provides for the appointment and functions of a board of the said authority; provides for the raising of charges for the provision of water and other services by the said authority; provides for the funds of the said authority; provides for the imposition and collection of a water levy; repeals the Regional Water Authority Act [Chapter20:16].

Link: www.law.co.zw/downloads/statutes/20/Zimbabwe National water Authority Act.pdf

WATER ACT

Enacted date and amendment date and section: Acts 31/1998, 22/2001, 13/2002, 14/2002

Description: provides for the development and utilization of the water resources of Zimbabwe; provides for the establishment, powers and procedures of catchment councils and sub-catchment councils; to provide for the granting of permits for the use of water; provides for the control of the use of water when water is in short supply; provides for the acquisition of servitudes in respect of water; provides for the protection of the environment and the prevention and control of water pollution; provides for the approval of combined water schemes; provides for matters relating to dam works; repeals the Water Act [Chapter 20:22].

Link: http://www.law.co.zw/downloads/statutes/20/Water Act.pdf

ENVIRONMENTAL MANAGEMENT ACT

Enacted date: Act 13/2002

Description: provides for the sustainable management of natural resources and protection of the environment, the prevention of pollution and environmental degradation, the preparation of a National Environmental Plan and other plans for the management and protection of the environment, the establishment of an Environmental Management Agency and an Environment Fund; amends references to intensive conservation areas and committees and associated matters in various acts; repeals the Natural Resources Act [Chapter 20:13], the Atmospheric Pollution Prevention Act [Chapter 20:03], the Hazardous Substances and Articles Act [Chapter 15:05] and the Noxious Weeds Act [Chapter 19:07].

Link: http://www.law.co.zw/downloads/statutes/20/Environmental Management Act.pdf

Acts pertaining to energy

ELECTRICITY ACT

Enacted date and amendment date and section: Act 4/2002, 3/2003, 6/2005 (s. 20)

Description: provides for the establishment of the Zimbabwe Electricity Regulatory Commission and for its functions and management; provides for the licensing and regulation of the generation, transmission, distribution and supply of electricity; provides for the repeal of the Electricity Act [*Chapter 13:05*].

Link: www.zera.co.zw/index_htm_files/electricity_act.pdf

PETROLEUM ACT

Enacted date and amendment date and section: Acts [*Chapter 13:22*] *Act 11/2006*

Description: provides for the establishment of the Petroleum Regulatory Authority and for its functions and management; provides for the licensing and regulation of the petroleum industry.

Link: www.zera.co.zw/index_htm_files/petroleum_act.pdf

ENERGY REGULATORY ACT

Enacted date and amendment date and section: Acts 2011[Chapter 13:23]

Description: provides for the establishment of the Energy Regulatory Authority and for its functions and management; amends the Electricity Act [*Chapter 13:19*] (Act No. 4 of 2002) and the Petroleum Act [*Chapter 13:22*] (Act No. 11 of 2006); provides for the establishment of an energy regulatory authority and board thereof.

Link: www.zera.co.zw/index_htm_files/energy_regulat_authority_act.pdf

Acts pertaining to public health regulations

PUBLIC HEALTH ACT

Enacted date and amendment date and section: Acts 19/1924, 3/1930, 37/1938 (ss. 3 and 22), 10/1945, 4/1948, 1/1953, 18/1957(Federal), 21/1963, 96/1964, 33/1968, 62/1969, 12/1973 (s. 270), 10/1974; 42/1976(s.37), 37/1977 (s. 24), 5/1985, 8/1988 (s. 164), 11/1991 (s. 23); Ord. 6/1980, 12/1997(s. 12), 6/2000, 22/2001, 14/2002, 2/2002;R.G.N.s 683/1963, 214/1964, 217/1970, 899/1978

Description: makes provision for public health covering administration, infectious diseases, venereal diseases, international sanitary regulations, water and food supplies, infant nutrition, sanitation and housing, etc.

Link: www.parlzim.gov.zw/attachments/article/101/PUBLIC_HEALTH_ACT_15_09.pdf

NOXIOUS WEEDS ACT

Enacted date and amendment date: Acts 22/1926, 37/1938 (s. 3), 29/1951 (s. 2), 61/1966 (s. 78), 57/1972 (s. 13), 28/1979, 20/1982, 8/1988 (s. 164); R.G.N.s 153/1963, 628/1963, 214/1964,217/1970, 343/1976; 885/1978;S.I. 170/1986.

Description: makes provision for the eradication of noxious weeds.

Link: www.parlzim.gov.zw/attachments/article/105/NOXIOUS_WEEDS_ACT_19_07.pdf

DAIRY ACT

Enacted date and amendment date and section: Acts 28/1937, 29/1952, 14/1962 (s. 2), 61/1966 (s. 72), 12/1973 (s. 270), 29/1976, 17/1977, 37/1977 (s. 8), 22/2001; R.G.N.s 637/1963, 214/1964, 217/1970, 378/1972

Description: consolidates and amends the laws relating to the regulation and control of the dairy industry; ensures that dairy produce is pure, wholesome and unadulterated.

Link: www.law.co.zw/index.php/legislation-a.../doc.../1451-dairy-act.pdf

PLANT PESTS AND DISEASES ACT

Enacted date and amendment date: Acts 11/1958 (Federal), 33/1970, 55/1973, 41/1978 (s. 11), 39/1979, 16/1989; R.G.N.s 653/1963, 217/1970

Description: provides for the eradication and prevention of the spread of plant pests and diseases in Zimbabwe.

Link: www.law.co.zw/downloads/statutes/19/Plant Pests And Diseases Act.pdf

ANIMAL HEALTH ACT

Enacted date and amendment date and section: Acts 5/1960 (Federal), l5/1962 (Federal), 32/1963 (Federal), 41/1978 (s. 10), 20/1982, 8/1983, 8/1988, 16/1990, 22/2001;R.G.Ns 638/1963, 95/1964, 745/1964216/1970, 217/1970, 452/1970

Description: provides for the eradication and prevention of the spread of animal pests and diseases in Zimbabwe.

Link: www.law.co.zw/downloads/statutes/19/Animal Health Act.pdf

MEDICINES AND ALLIED SUBSTANCES CONTROL ACT

Enacted date and amendment date and section: Acts 14/1969, 62/1971, 35/1974, 20/1978,

41/1978 (s. 35) 39/1979, 7/1987, 11/1988, 18/1989 (s. 27), 1/1996, 6/2000, 22/2001; R.G.N. 899/1978

Description: establishes a Medicines Control Authority of Zimbabwe and confers functions on the said authority in relation to the registration of medicines; provides for the Zimbabwe Regional Medicines Control Laboratory and for its functions; provides for the appointment of a director-general of the Medicines Control Authority and for the keeping of a Medicines Register; provide for certain prohibitions, controls and restrictions relating to medicines and other substances.

Link: www.mcaz.co.zw/index.php/downloads/category/8-acts?download=6:medicines-and-allied-substances-control-act-chapter-1503

FOOD AND FOOD STANDARDS ACT

Enacted date and amendment date and section: Acts 25/1971, 39/1973 (s. 52), 61/1973 (s.8), 42/1976 (s. 35), 32/1979 (s.12), 29/1981, 8/1988, 22/1994, 22/2001

Description: provides for the sale, importation and manufacture for sale of food in a pure state; prohibits the sale, importation and manufacture for sale of food which is falsely described; provides for the fixing of standards relating to food and matters incidental thereto.

Link: www.parlzim.gov.zw/attachments/article/101/FOOD_AND_FOOD_STANDARDS_ACT_15_04.pdf

NATIONAL REGULATIONS AND POLICIES

INDUSTRIAL DEVELOPMENT POLICY 2012–2016

Enacted date: 2012

Description: the vision of this policy is to transform Zimbabwe from a producer of primary goods into a producer of processed value-added goods for both the domestic and export markets.

Link: www.miit.gov.zw/policiess/viewdownload/3-policies/17-zimbabwe-industrial-development-policy-2012-2016-pdf

NATIONAL BIOTECHNOLOGY POLICY

Enacted date: 2005

Description: the National Biotechnology Policy seeks to ensure the safe and judicious use of biotechnology, with a view to maximizing its potential benefits while minimizing any adverse effects on health (human and animal) and the environment.

Link: www.vertic.org/media/NationalLegislation/Zimbabwe/ZW_National_Biotechnology_Authority_Act.pdf

NANOTECHNOLOGY RESEARCH POLICY

Enacted date: 2005

Description: one of the six goals of the *Second Science, Technology and Innovation Policy* launched in June 2012 is 'to learn and utilize emerging technologies to accelerate development'. Nanotechnology falls under this goal, the government having mapped out a National Nanotechnology Programme (see Box 15).

Link: www.nanotec.or.th/en/?p=1585

ENERGY POLICY

Enacted date: 2012

Description: the National Energy Policy seeks to promote the optimal supply and utilization of energy for socio-economic development in a safe, sustainable and environmentally friendly manner. It is clear that the policy's objectives will remain valid even though the social, political, environmental and economic situations change continually. Such changes will necessitate policy review, with reference being made to the scenarios prevailing in the entire economy and international environment. A consultative process was key to the design and development of the National Energy Policy to ensure that the views of all stakeholders in the country were taken into account.

Link: www.zera.co.zw/index_htm_files/Energy_Policy.pdf

INTERNATIONAL AGREEMENTS ON SETI MATTERS

SOUTH AFRICA

Entry into Force: 2 March 1995

Description: Agreement for the establishment of a Joint Commission for Economic, Technical Scientific and Cultural Cooperation

Entry into Force: 29 November 2007

Description: Agreement on Scientific and Technological Co-operation

MALAWI

Entry into Force: 2006

Description: Memorandum of Understanding between Zimbabwe and Malawi in the Fields of Science and Technology

INDIA

Enacted Date: 2006

Description: Memorandum of Understanding between Zimbabwe and India in the Fields of Science and Technology

AFRICAN UNION

The African Union promotes research in science and technology by providing the Kwame Nkrumah African Union/TWAS Young Scientists National Awards.

SADC PROTOCOL ON SCIENCE, TECHNOLOGY AND INNOVATION

The overall objective of this protocol is to foster co-operation and promote the development, transfer and mastery of STI in member states in order to: (a) establish institutional mechanisms to strengthen regional cooperation and co-ordination of STI; (b) institute management and co-ordination structures with clearly defined functions which will facilitate the implementation of regional STI programmes; (c) pool resources for R&D and innovation within the region; (d) optimize public and private investment in R&D within the region and leverage external contributions; (e) demystify STI by promoting public understanding and awareness and meaningful participation in these disciplines. Under the protocol, member States commit themselves to forging strong partnerships with the African diaspora with a view to advancing the region's scientific and technological development.

UNITED NATIONS CONVENTIONS

Zimbabwe is signatory to leading international conventions that include the United Nations Convention on Biological Diversity, United Nations Framework Convention on Climate Change and the United Nations Convention to Combat Desertification. These conventions are an international response to a global environmental crisis that is largely attributed to a global population explosion, unsustainable consumption patterns, as well as humanity's over-reliance on fossil fuels.

REGIONAL TREATIES ON INTELLECTUAL PROPERTY RIGHTS

LUSAKA AGREEMENT ON THE CREATION OF THE AFRICAN REGIONAL INTELLECTUAL PROPERTY ORGANIZATION (ARIPO)

Adopted: 9 December 1976 in Lusaka

Description: Zimbabwe became a party to this agreement establishing ARIPO on 11 November 1980. The objectives of ARIPO are, *inter alia*: to promote the harmonization and development of intellectual property laws and matters related thereto, appropriate to the needs of its members and those of the region as a whole, and to promote – within its member states – the development of copyright and related rights, ensuring that these rights contribute to the economic, social and cultural development of members and of the region as a whole. The organization has the following organs: Council of Ministers, Administrative Council and the Secretariat.

Link: www.wipo.int/wipolex/en/other_treaties/details.jsp?group_id=21&treaty_id=202

HARARE PROTOCOL ON PATENTS AND INDUSTRIAL DESIGNS WITHIN THE FRAMEWORK OF THE AFRICAN REGIONAL INDUSTRIAL PROPERTY ORGANIZATION (ARIPO)

Adopted: 25 April 1984

Description: Zimbabwe became a State Party to this protocol on 25 April 1984. The agreement empowers ARIPO to grant patents and register utility models and industrial designs and to administer these on behalf of the contracting states. The protocol also details the application process and requirements for applicants.

Link: www.wipo.int/wipolex/en/other_treaties/details.jsp?group_id=21&treaty_id=204

BANJUL PROTOCOL ON MARKS WITHIN THE FRAMEWORK OF THE AFRICAN REGIONAL INDUSTRIAL PROPERTY ORGANIZATION (ARIPO)

Adopted: 6 March 1997

Description: this protocol entrusts ARIPO with the registration of marks and the administration of the same on behalf of the contracting states. It sets out the application process for the filing of marks and the requirements for applicants.

Link: www.wipo.int/wipolex/en/other_treaties/details.jsp?group_id=21&treaty_id=203

SWAKOPMUND PROTOCOL ON THE PROTECTION OF TRADITIONAL KNOWLEDGE AND EXPRESSIONS OF FOLKLORE WITHIN THE FRAMEWORK OF THE AFRICAN REGIONAL INTELLECTUAL PROPERTY ORGANIZATION (ARIPO)

Signed: 9 August 2010 by nine ARIPO member States: Botswana, Ghana, Kenya, Lesotho, Liberia, Mozambique, Namibia, Zambia and Zimbabwe. The protocol will enter into force once six ARIPO member states have deposited instruments of ratification (for signatories) or accession (for non-signatories). Any state that is a member of the African Union or the United Nations Economic Commission for Africa may also sign up to the protocol (as of May 2014, it had not yet come into force).

Description: the purpose of the protocol is: (a) to protect traditional knowledge holders against any infringement of their rights as recognized by the protocol and; (b) to protect expressions of folklore against misappropriation, misuse and unlawful exploitation beyond their traditional context. The protocol grants local communities the rights to their folklore and, where such right of ownership has been infringed, legal remedies are available. Contracting Parties may maintain registers or other records of knowledge.

Link: www.archivalplatform.org/images/resources/Swakopmund_Protocol.pdf

WIPO-ADMINISTERED TREATIES

CONVENTION ESTABLISHING THE WORLD INTELLECTUAL PROPERTY ORGANIZATION (29 DECEMBER 1981)

Link: www.wipo.int/wipolex/en/wipo_treaties/details.jsp?treaty_id=1

PATENT COOPERATION TREATY (11 JUNE 1997)

Link: www.wipo.int/wipolex/en/wipo_treaties/details.jsp?treaty_id=6

PARIS CONVENTION FOR THE PROTECTION OF INDUSTRIAL PROPERTY (15 APRIL 1998)

Link: www.wipo.int/wipolex/en/wipo_treaties/details.jsp?treaty_id=2

PATENT COOPERATION TREATY (30 OCTOBER 2003)

Link: www.wipo.int/wipolex/en/wipo_treaties/details.jsp?treaty_id=6

WIPO PERFORMANCES AND PHONOGRAMS TREATY (27 JANUARY 2005)

Link: www.wipo.int/wipolex/en/wipo_treaties/details.jsp?treaty_id=20

HAGUE AGREEMENT CONCERNING THE INTERNATIONAL DEPOSIT OF INDUSTRIAL DESIGNS (5 DECEMBER)

Link: www.wipo.int/wipolex/en/wipo_treaties/details.jsp?treaty_id=9

WIPO COPYRIGHT TREATY (27 JANUARY 2005)

Link: www.wipo.int/wipolex/en/wipo_treaties/details.jsp?treaty_id=16

MULTILATERAL TREATIES RELATED TO INTELLECTUAL PROPERTY

- Convention relating to the Status of Stateless Persons (18 April 1980)
- Convention and Statute on Freedom of Transit (18 April 1980)
- Agreement on the Importation of Educational, Scientific and Cultural Materials (18 April 1980)
- Convention concerning the Protection of the World Cultural and Natural Heritage (16 November 1982)
- Convention (IV) relative to the Protection of Civilian Persons in Time of War (7 September 1983)
- Convention (II) for the Amelioration of the Condition of Wounded, Sick and Shipwrecked Members of Armed Forces at Sea (7 September 1983)
- Convention (I) for the Amelioration of the Condition of the Wounded and Sick in Armed Forces in the Field (7 September 1983)
- International Covenant on Economic, Social and Cultural Rights (13 August 1991)
- Protocol (II) Additional to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of Non-International Armed Conflicts (19 April 1993)
- Protocol (I) Additional to the Geneva Conventions of 12 August 1949, and relating to the protection of victims of international armed conflicts (19 April 1993)
- United Nations Framework Convention on Climate Change (21 March 1994)
- United Nations Convention on the Law of the Sea (16 November 1994)
- Convention on Biological Diversity (9 February 1995)
- World Trade Organization (WTO) – Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement) (1994) (5 March 1995)
- Agreement establishing the World Trade Organization (WTO) (5 March 1995)
- Convention for the Protection of Cultural Property in the Event of Armed Conflict (9 September 1998)
- Cartagena Protocol on Biosafety to the Convention on Biological Diversity (26 May 2005)
- International Treaty on Plant Genetic Resources for Food and Agriculture (3 October 2005)
- Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property (30 August 2006)
- Convention for the Safeguarding of the Intangible Cultural Heritage (30 August 2006)
- Convention on the Protection and Promotion of the Diversity of Cultural Expressions 2005 (15 August 2008)
- Kyoto Protocol to the United Nations Framework Convention on Climate Change (28 September 2009)
- Stockholm Convention on Persistent Organic Pollutants (30 May 2012)
- International Plant Protection Convention (30 November 2012)
- Optional Protocol to the Convention on the Rights of Persons with Disabilities (23 October 2013)
- Convention on the Rights of Persons with Disabilities (23 October 2013)

Link: www.wipo.int/wipolex/en/profile.jsp?code=ZW

TREATIES RELATED TO REGIONAL ECONOMIC INTEGRATION

GLOBAL SYSTEM OF TRADE PREFERENCES AMONG DEVELOPING COUNTRIES (19 APRIL 1989)

Link: www.wipo.int/wipolex/en/other_treaties/details.jsp?group_id=24&treaty_id=432

TREATY ESTABLISHING THE SOUTHERN AFRICAN DEVELOPMENT COMMUNITY (30 SEPTEMBER 1993)

Link: www.wipo.int/wipolex/en/other_treaties/details.jsp?group_id=24&treaty_id=299

ABUJA TREATY ESTABLISHING THE AFRICAN ECONOMIC COMMUNITY (AEC) (12 MAY 1994)

Link: www.wipo.int/wipolex/en/other_treaties/details.jsp?group_id=24&treaty_id=217

TREATY ESTABLISHING THE COMMON MARKET FOR EASTERN AND SOUTHERN AFRICA (25 FEBRUARY 1999)

Link: www.wipo.int/wipolex/en/other_treaties/details.jsp?group_id=24&treaty_id=218

PROTOCOL ON TRADE IN THE SADC (JANUARY 25, 2000)

Link: www.wipo.int/wipolex/en/other_treaties/details.jsp?group_id=24&treaty_id=312

CONSTITUTIVE ACT OF THE AFRICAN UNION (MAY 26, 2001)

Link: www.wipo.int/wipolex/en/other_treaties/details.jsp?group_id=24&treaty_id=221

THE GEORGETOWN AGREEMENT (FORMALLY ESTABLISHING THE AFRICAN, CARIBBEAN AND PACIFIC GROUP OF STATES, THE "ACP GROUP" (LAST AMENDMENT AMENDED ON NOVEMBER 28, 2003)

Link: www.wipo.int/wipolex/en/other_treaties/details.jsp?group_id=24&treaty_id=220

LEGAL LITERATURE ON INTELLECTUAL PROPERTY

INTELLECTUAL PROPERTY LAW DEVELOPMENTS IN ZIMBABWE (2010)

Subject Matter: enforcement of intellectual property and related laws, regulatory body, trademarks

Link: www.wipo.int/wipolex/en/text.jsp?file_id=216376

UNESCO WORLD ANTI-PIRACY OBSERVATORY, ZIMBABWE

Subject Matter: competition, copyright and related rights (neighbouring rights), enforcement of intellectual property and related laws, industrial property, regulatory body

Link: www.unesco.org/culture/pdf/zimbabwe_cp_en

Inventory of SETI operational policy instruments in Zimbabwe

Zimbabwe has five SETI operational policy instruments. These are presented in the tables overleaf. In addition, it counts several policy instruments for the social appropriation of science (see Box 18) and strategic policy instruments for promoting innovation and adding value to diamond exports (see Box 19).

Figure 33 shows the distribution of operational policy instruments in Zimbabwe by objective and goal, broken down into the categories used by the GO→SPIN programme.

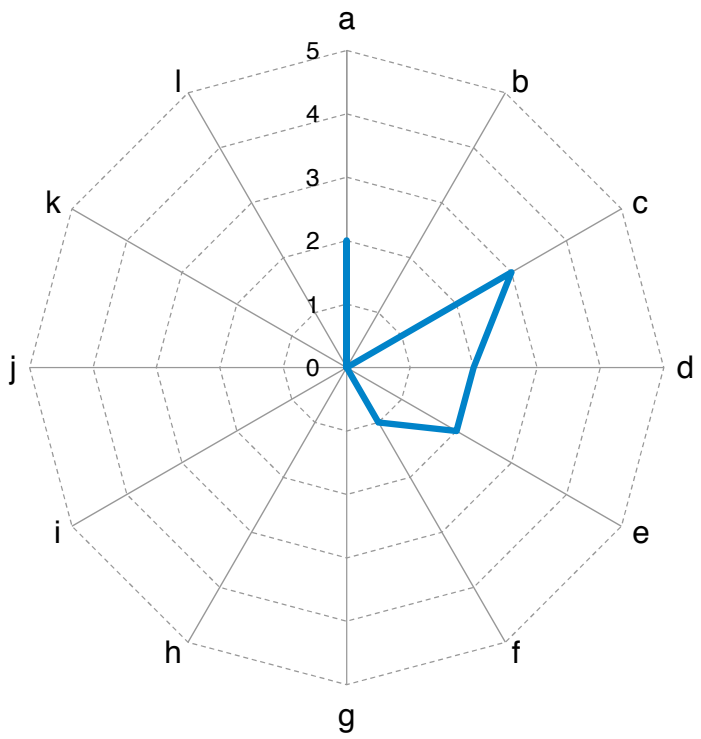


Figure 33: Distribution of SETI operational policy instruments according to the GO→SPIN categories of objective and goal. Source: UNESCO

Key

a. Strengthening the production of new endogenous scientific knowledge.
b. Strengthening the infrastructure of research laboratories in the public and private sectors.
c. Human resources for research, innovation and strategic planning. Capacity-building, education and training of specialized human capital for (1) the production of new scientific knowledge; (2) development of new technologies; (3) promotion of innovation within the productive and services systems and (4) management of the knowledge society.
d. Strengthening gender equality for research and innovation.
e. Strengthening the social appropriation of scientific knowledge and new technologies.
f. Development of strategic technological areas and new niche products and services with high added value. Promotion and development of innovation in the production of goods and services. Promotion of start-ups in areas of high technology.
g. Strengthening programmes on science education at all levels (from primary school to postgraduate)
h. Promotion of the development of green technologies and social-inclusion technologies.
i. Promotion of indigenous knowledge systems
j. Research and innovation eco-system: strengthening co-ordination, networking and integration processes which promote synergies among the different actors of the national scientific technological and productive innovation system (i.e. government, university and productive sectors).
k. Strengthening the quality of technology foresight studies to: assess the potential of high-value markets; develop business plans for high-tech companies; construct and analyse long-term scenarios and; provide consulting services and strategic intelligence.
l. Strengthening regional and international co-operation, networking and promotion of SETI activities.

OPERATIONAL SETI POLICY INSTRUMENT 1

- **Title of the SETI operational policy instrument**: funding of research projects for national socio-economic development
- **Keywords:** research grants, socio-economic development, call for proposals
- **Overview:** call for research proposals by the Research Council of Zimbabwe in the following four priorities theme areas: (a) Sustainable environmental and resource management, (b) Promoting and maintaining good health, (c) Social sciences and humanities and, (d) National security. The specific goal areas to be covered are listed under each thematic area. Interdisciplinary and cross-cutting proposals in the thematic areas and goals are encouraged.
- **Objectives of the plan (or the SETI policy) to which the instrument relates:**

  a. *Sustainable Environmental and Resource Management:* transforming agriculture; value addition to Zimbabwe's natural resources; water as a critical resource (availability and utilization); sustainable use of Zimbabwe's ecosystems including forests and biodiversity; responding to climate change and variability; understanding and developing deep earth resources; developing sustainable energy resources; overcoming land degradation and; bringing to life Zimbabwe's STI system.

  b. *Promoting and Maintaining Good Health:* increasing access to health facilities; preventive health care; revitalizing Zimbabwe's national health delivery system; a healthy start to life (countering the impact of genetic, maternal, social and environmental factors which dispose infants to ill-health and reduce their well-being and life potential).

  c. *Social Sciences and Humanities:* strengthening Zimbabwe's social and economic fabric; strengthening national policy making policies; understanding the SADC region and the world and; intellectual property rights in Zimbabwe.

  d. *National Security of Zimbabwe:* protecting Zimbabwe from terrorism and crime; transformational defence technologies; protecting Zimbabwe from invasive diseases and pests; safeguarding the proper exploitation of the country's resources and safeguarding critical Infrastructure.

- **Specific objectives:** a. strengthening the production of new endogenous scientific knowledge; c. human resources for research, innovation and strategic planning: capacity-building, education and training of specialized human capital for (1) the production of new scientific knowledge; (2) development of new technologies; (3) promotion of innovation within the productive and services systems and; (4) management of the knowledge society
- **Sectorial or horizontal approach of the instrument**: sectorial, the benefits go to a specific knowledge discipline, technological area, productive sector or a specific issue
- **Mode of support/Type of mechanism**: research grants
- **Conditions for applying for the instrument**: funding is open, on a competitive basis, to: Zimbabwean tertiary education institutions; Zimbabwean research institutions; government research departments; non-profit organizations affiliated to a Zimbabwean-approved public institute; consortia of the above, with one institution as lead applicant, assuming responsibility and accountability for the consortium; other institutions that may from time to time be involved in approved research. Where an institution's eligibility to apply for funding from the Research Council of Zimbabwe may be in question, such institutions must request and receive confirmation of eligibility from the said council. While research proposals in all disciplines are eligible for funding, the council particularly encourages collaborative projects across institutions and disciplines from focus areas set out in the specific call for proposals. All proposals received are subject to the peer-review and adjudication process. Proposals must, where applicable, include a plan for: commercialization (including market potential and market analysis); intellectual property ownership and disposition; human capital development; research sustainability.

- **Target groups/Beneficiaries**: academic staff from universities, researchers from research institutions in the country
- **Eligibility/Selection criteria**: the following criteria will be applied through a confidential peer-review process to assess the submissions for research proposals: scientific quality (especially elaboration of research question, methods and research plan); relevance and link to the priority theme or goal; feasibility, innovativeness and interdisciplinary nature of the research project; scientific competence of the applicants submitting the proposal; and involvement of young researchers (40 years and younger).
- **Eligible costs**: The Research Council of Zimbabwe will fund eligible direct operating costs (including salaries and benefits and limited costs for facilities and equipment, management and administration), as well as a portion of indirect (overhead) costs. Grant funds will be provided pursuant to the execution of a grant agreement between the Research Council of Zimbabwe and the lead institution and the applicant. The maximum level of funding for selected proposals is US$20 000.
- **Source of funding**: Government of Zimbabwe
- **Mode of disbursement of financial resources:** disbursed to financial accounting officers of research institutions
- **Annual budget:** n/a
- **Continuity of the instrument over time:** several years
- **Geographical coverage:** national
- **Results, outcome and evidence of success of a given measure:** n/a
- **Relevant link:** www.rcz.ac.zw/index.php/en/component/content/article/155.html

OPERATIONAL SETI POLICY INSTRUMENT 2

- **Title of the SETI operational policy instrument**: competitive research grants within individual universities
- **Keywords:** small research grants, university, academic research, research education
- **Overview:** most of the state and private universities have their own research grants funded using their own resources. The main goal of the internal research grants is to promote research by members of the institution's own academic staff. Institutional research grants are the major research funding resource for local universities.
- **Objectives of the plan (or the SETI policy) to which the instrument relates**: provide seed money to start research by young academic members of staff. Increase scientific productivity of the universities. Allow members to attend regional and international conferences to present their research.
- **Specific objectives: a.** strengthening the production of new endogenous scientific knowledge; **c.** human resources for research, innovation and strategic planning. Capacity-building, education and training of specialized human capital for (1) the production of new scientific knowledge; (2) development of new technologies
- **Sectorial or horizontal approach of the instrument**: horizontal
- **Mode of support/Type of mechanism**: research grants and conference attendance grants
- **Conditions to apply for the instrument**: members of academic staff within the institution, whether tenured or not tenured. Funding is not open to outsiders.
- **Target groups/Beneficiaries**: university teachers and researchers
- **Eligibility/Selection criteria**: research proposals are peer-review assessed by institutional Research and Postgraduate Committees using specified criteria. Funding is not open to outsiders.

- **Eligible costs**: partial or full funding of the research and participation in scientific conferences
- **Source of funding**: internal resources e.g. from tuition fees
- **Mode of disbursement of financial resources:** withdrawn from the institutional research centre per activity of the research in the proposal
- **Annual budget:** n/a
- **Continuity of the instrument over time:** several years
- **Geographical coverage:** local (within each university)
- **Results, outcome and evidence of success of a given measure:** n/a
- **Relevant links:** www.uz.ac.zw, www.buse.ac.zw, www.nust.ac.zw, www.cut.ac.zw, www.msu.ac.zw, www.gzu.ac.zw

OPERATIONAL SETI POLICY INSTRUMENT 3

- **Title of the SETI operational policy instrument**: Zimbabwe Manpower Development Fund (ZIMDEF)
- **Keywords:** ZIMDEF, human resources, capacity-building
- **Overview:** the broad objective of ZIMDEF is to finance the development of critical and highly skilled human capital through a 1% training levy paid by registered companies in Zimbabwe
- **Objectives of the plan (or the SETI policy) to which the instrument relates**: to promote human resources development at the highest educational level
- **Specific objectives (#): c.** Human resources for research, innovation and strategic planning. Capacity-building, education and training of specialized human capital for (1) the production of new scientific knowledge; (2) development of new technologies; (3) promotion of innovation within the productive and services systems and (4) management of the knowledge society. **d.** Strengthening gender equality for research and innovation
- **Sectorial or horizontal approach of the instrument**: horizontal
- **Mode of support/Type of mechanism**: annual
- **Conditions to apply for the instrument**: Apprentices: (1) those which are directly recruited by the Ministry of Higher and Tertiary Education, Science and Technology Development through the Industrial Training and Trade Testing Department and (2) those who are directly recruited by employers. For tertiary institutions, employers and polytechnic students, the requirements can be downloaded from the webpage.
- **Target groups/Beneficiaries**: apprentices, tertiary and higher education institutions, employers, polytechnic students
- **Eligibility/Selection criteria**: details for each individual category are provided at www.zimdef.org.zw/index.php/media-centre/downloads
- **Eligible costs**: **(I)** apprentices: assists in payment of tuition, boarding fees and wages of apprentices for 1st and 2nd year of training. **(II)** For tertiary institutions: (a) purchasing of training equipment and consumables in all polytechnics and technical colleges; (b) development of training infrastructure; (c) payment of B-Tech allowances to the B-Tech programmes lecturers; (d) purchasing of textbooks; (e) purchasing and funding of training incidentals which include awards and prizes; (f) payment of grants to non-governmental institutions involved in human capital development. **(III)** Employers may claim: (i) rebates if they provide trade testing facilities, (ii) release their employees for part time lecturing at training institutions of the Ministry of Higher and Tertiary Education, Science and Technology Development and those employers who incur expenses for employees who successfully

complete courses run the by Higher Education Examination Council, Chartered Institute of Secretaries, International Air Transport Association, Chartered Institute of Transport, Southern African Association of Accountancy, Zimbabwe Institute of Management, among others (iii) payment of skilled workers expenses including upgrade training courses. (iv) Polytechnic students: payment of industrial attachment allowances and purchasing of training equipment and consumables for the students.

- **Source of funding**: 1% Training Levy paid by registered companies in Zimbabwe
- **Mode of disbursement of financial resources:** several modes according to different target groups, details are available at www.zimdef.org.zw/index.php/media-centre/downloads
- **Annual budget:** n/a
- **Continuity of the instrument in time:** 1984 reformed in 1996
- **Geographical coverage:** national
- **Results, outcomes and evidence of success of a given measure:** n/a
- **Relevant link**: www.zimdef.org.zw/

OPERATIONAL SETI POLICY INSTRUMENT 4

- **Title of the SETI operational policy instrument**: Scholarships/loans programme of the Ministry of Higher and Tertiary Education, Science and Technology Development
- **Keywords:** undergraduate and graduate scholarships, human resources at tertiary level
- **Overview:** the scholarship programme is defined as a meritorious financial award that is given to a Zimbabwean citizen to pursue professional or academic studies in those areas where specialists are in short supply in Zimbabwe; a loan is defined as financial aid awarded to Zimbabwean citizens who are already studying abroad and find themselves in a financial predicament.
- **Objectives of the plan (or the SETI policy) to which the instrument relates**: to promote human resources development at the highest educational level
- **Specific objectives: c.** Human resources for research, innovation and strategic planning. Capacity-building, education and training of specialized human capital for (1) the production of new scientific knowledge; (2) development of new technologies; (3) promotion of innovation within the productive and services systems and (4) management of the knowledge society. **d.** Strengthening gender equality for research and innovation
- **Sectorial or horizontal approach of the instrument**: horizontal
- **Mode of support/Type of mechanism**: annual
- **Conditions to apply for the instrument**: (1) excellent academic qualifications: at least a 2.1 degree aggregate at first degree level for postgraduate studies and at least 8 points at 'A' level for undergraduate studies; (2) provincial distribution: scholarships are considered a national cake, hence all provinces of the country should benefit; (3) shortages of personnel in critical areas: scholarships should be provided and awarded to Zimbabweans who intend to pursue training in areas where there is a critical shortage of personnel; (4) gender equity: in conformity with the government's gender equity policy, both male and female applicants are considered equally; (5) for undergraduate and postgraduate studies, the Scholarship Committee uses interviews as one of the selection criteria;

(6) for undergraduate and postgraduate studies, work experience is also considered as a determinant for selection; (7) some donor countries now request a thorough medical examination, including for HIV Aids; (8) some donor countries also specify certain age limits for beneficiaries.

- **Target groups/Beneficiaries**: scholarships for undergraduate and graduate students
- **Eligibility/Selection criteria**: recruitment process: long-term scholarships are always advertised in the press. This enables the ministry to receive applications from all 10 provinces in the country. Suitably qualified and interested Zimbabweans are given a maximum of three weeks to submit their application to the ministry. After the deadline, all applications are stored in the computer system to create a database. Specific reports can be generated from this database for use. The selection process is presided over by a highly technical and professional Inter-ministerial Scholarship Committee. The Permanent Secretary of Higher and Tertiary Education chairs the Committee. The other committee members are Permanent Secretary of the Ministry of Education, Sport and Culture, President of the Zimbabwe Institution of Engineers, Executive Director of the Research Council of Zimbabwe, Dean of Medicine at the University of Zimbabwe, Secretary-General of the National Commission for UNESCO and Ministry of Higher and Tertiary Education. Senior ministry officials provide the secretariat. The ministry also manages the welfare of students under the Fort Hare Presidential Scholarship Programme; these are students who have been selected under this programme of His Excellency, the President of the Republic of Zimbabwe, Robert Mugabe.
- **Eligible costs**: Scholarships: for the purposes of pursuing training and development studies both abroad and locally. These fall under two categories: short- and long-term scholarship programmes. Short-term scholarship programmes are offered for specific training courses of a maximum duration of 12 months. They normally cater for on-the-job training programmes. Short-term scholarships are sector-specific, hence, these are normally referred to specific user organizations. Long-term scholarships are normally for undergraduate and postgraduate studies. Loans: financial aid awarded to Zimbabwean citizens who are already studying abroad and find themselves in a financial predicament. This predicament may have been caused either by the death of the main sponsor, retrenchment from work and other incapacitating factors. For instance, a student's sponsoring parent might die while the student is enrolled in his/her final year of study. The loan avoids a negative return on the investment already made by the ministry. The ministry's committee consider such cases accordingly and awards a 100% loan if the applicant is found to be deserving. Unlike the scholarship mentioned above, loans are redeemable/repayable over a five-year period after the completion of study. The loans are entirely a ministry scheme; this means that the scheme's viability and sustainability depends on the availability of such funds. Currently, the scheme is no longer sustainable because the Ministry of Finance has not been allocating funds to it.
- **Source of funding**: Governmental budget appropriations
- **Mode of disbursement of financial resources:** n/a
- **Annual budget:** n/a
- **Continuity of the instrument over time:** n/a
- **Geographical coverage:** covers studies within Zimbabwean universities and universities abroad
- **Results, outcome and evidence of success of a given measure:** The scholarship system has seen more than 4 000 Zimbabwean citizens trained abroad in areas where there is a critical shortage, such as in medicine, engineering, architecture, quantity surveying, computer sciences, actuarial sciences and law.
- **Relevant link**: www.mhtestd.gov.zw/index.php/scholarships

BOX 17 – TWO EXAMPLES OF POLICY INSTRUMENTS FOR THE SOCIAL APPROPRIATION OF SCIENCE

Zimbabwe international research symposia

To date, the Research Council of Zimbabwe has hosted nine international research symposia. These bring together researchers, policy-makers and industrialists from within and beyond Zimbabwe. Local and regional researchers present their research results and forge linkages with the end-users. Stakeholders find the symposia an opportunity to foster interaction among government, industry and academia. The nine symposia have taken place on the following dates:

- 13–14 February 2013: Driving Socio-Economic Development through Research Output
- 31 January – 1 February 2007: Knowledge-based Development for Zimbabwe
- 1–3 September 2004: Impact of Innovative Science and Technology on National Wealth Creation
- 3–5 August 1999: A century of Science and Technology Challenges for the Next Millennium
- 24–26 September 1996: Towards Capacity Building in Science and Technology
- 20–22 September 1994: Advances in Productive and Sustainable Applied Technologies
- 6–8 October 1992: Innovation, Self-Reliance and Development
- 11 –13 September 1990
- 4–6 January 1988

Mathematics Olympiad

The Mathematics Olympiad was founded in 2000 by Old Mutual Zimbabwe (as part of its social responsibility), in conjunction with the University of Zimbabwe's Mathematics Department. Zimbabwe's Mathematics Olympiad is affiliated to the International Mathematics Olympiad.

The Olympiad, which started off as a three-round competition, was designed to promote mathematics at high-school level and to identify mathematical talent. One of the previous winners, Clement Chinaka, studied actuarial science and advanced in the field to become the Chief Actuary of Old Mutual. The annual competition has since been limited to two rounds.

Some of the winners of the Olympiad have participated in the Pan-African Mathematics Olympiad (PAMO), one student, Kudzai Ndondo (formerly from Victoria High School), bringing home a bronze medal.

The role of the University of Zimbabwe's Mathematics Department is to set questions for both the first and final rounds, mark the papers, provide the solutions and, lastly, come up with the Top 20 students, from which the Top 3 are selected. Old Mutual's role is to administer the whole programme.

The Mathematics Olympiad has gained great support and popularity in schools all over Zimbabwe, as it has become a respected measure of students' performance against their peers in other schools.

OPERATIONAL SETI POLICY INSTRUMENT 5

- **Title of the SETI operational policy instrument**: Tobacco Marketing Board and Levy Fund (see also Box 9).
- **Keywords:** levy for research funding, tobacco industry
- **Overview:** The funds received by a recognized Growers Association, Buyers Association or registered individuals from the tobacco levy account are kept in a separate fund and are used to promote the interests of those who paid the levy; part of the funds are applied to research, training or promotion in connection with the production or marketing of tobacco.
- **Objectives of the plan (or the SETI policy) to which the instrument relates**: to provide funding for research and training in relation with the production and marketing of tobacco
- **Specific objectives: f.**(2) promotion and development of innovation in the production of goods and services
- **Sectorial or horizontal approach of the instrument**: Sectorial
- **Mode of support/Type of mechanism**: annual
- **Conditions to apply for the instrument**: the beneficiary should be a registered grower association, buyer association or registered grower
- **Target groups/Beneficiaries**: registered growers associations, registered buyers associations or registered individual producers
- **Eligibility/Selection criteria**: determined by the Tobacco Marketing and Levy Act
- **Eligible costs**: research and training in connection with the production and, additionally or alternatively, marketing of tobacco.
- **Source of funding**: Tobacco levy
- **Mode of disbursement of financial resources:** from the moneys in the tobacco levy account, the Minister of Agriculture pays in each financial year all recognized growers associations and recognized buyers associations the amount he/she considers to be required by the associations for the purposes of subsections (1) and (2) of section 26 of the act; and pays registered growers the amount he considers appropriate
- **Annual budget:** n/a
- **Continuity of the instrument in time:** 1955
- **Geographical coverage:** local
- **Results, outcome and evidence of success of a given measure:** quality of tobacco varieties improved, research and extension activities in the sector promoted, tobacco productivity improved
- **Relevant link:** www.law.co.zw/downloads/statutes/18/Tobacco%20Marketing%20And%20Levy%20Act.pdf

BOX 18 – STRATEGIC POLICY INSTRUMENTS FOR PROMOTING INNOVATION AND ADDING VALUE TO DIAMOND EXPORTS

Mining accounts for 15% of Zimbabwe's GDP and generates about US$1.7 billion in exports annually but the government receives royalties of only US$200 million.

Currently, the entire stock of diamonds is exported in raw form. The government is conscious of the need to implement new policy instruments, in order to promote diamond cutting and polishing in Zimbabwe and thereby optimize the economic returns on diamond exports and create an estimated 1 700 new jobs.

The government is currently analysing new legislation regulating the importation and movement of diamonds, in order to promote local cutting and polishing. The new legislation will introduce a statutory instrument regulating the movement of diamonds from the mines which extract them to the companies that cut and polish them, enabling them to import gems to augment the stock they receive from local suppliers.

A total of 27 diamond cutting and polishing companies have so far been licensed to conduct this business. The new legislation will act as an operational policy instrument by introducing the requirement that companies pay a 15% value-added tax and incur a 50% discount if they cannot cut and polish the diamonds but rather prefer to sell them to the Minerals Marketing Corporation of Zimbabwe.

Already, the government has slashed licence fees for local cutting and polishing firms, which initially had to pay US$1 000 for a year's licence fees and US$10 000 for 10 years. This comes at a time when the government is trying to ensure beneficiation and value addition in the mining sector to optimize the return on the country's diverse stock of minerals. Zimbabwe has diamond mines in Chiadzwa, in the Eastern Highlands and Murowa, in the Midlands province. It is believed that Zimbabwe has the potential to supply 25% of the rough stones sold on global markets annually.

Zimbabwe has been selling its diamonds on the Antwerp diamond exchange in Belgium and is planning more trial tenders in the Dubai and Shanghai markets. The country is seeking markets that generate the highest returns and is building up its experience of marketing gems prior to establishing its own local stock exchange later this year.

Zimbabwe raked in just over US$70 million from a second diamond trial tender in Antwerp last month, following a 29% rise in prices due, in part, to a cleaner parcel of the gems from Chiadzwa diamond fields. A total of 959 931 carats were put on sale by six Chiadzwa diamond mining companies, namely Jinan Mining, Marange Resources, DMC, DTZ, Mbada and Anjin.

Source: adapted from an article by Golden Sibanda in *The Herald*, p.B3, Harare, 4 March 2014

SWOT analysis of Zimbabwe's research and innovation system

This section focuses on the strengths, weaknesses, opportunities and threats (SWOT) which characterize Zimbabwe's research and innovation system. These characteristics are summarized in Table 46 on page 189. The analysis which follows is based on the information and data in preceding sections.

Strengths

- **Pioneering institutional background in Africa for research and innovation:** Zimbabwe founded its first research facilities more than a century ago. In the 1930s, it established the first research institutions for promoting innovation within the private sector. In the 1950s, it put in place one of the first operational policy instruments in the world, for the promotion of research and innovation, based on funding provided by a special levy imposed on the tobacco industry (see Box 9).
- **High literacy rate:** Zimbabwe has sustained one of the highest adult literacy rates (90%) in sub-Saharan Africa (59%) over a long period of time. This is a result of concerted efforts and policies by the Government of Zimbabwe such as school expansion, teacher training, and resource exploitation improvements which improved education access by the majority of the people.
- **Well-developed education system:** Zimbabwe has a well-developed education system from primary school level through to secondary school and university. According to the last census (c. 2012), 46.9% of the population aged 20–64 years has completed secondary schooling and 9.3% also holds a university or other tertiary qualification. Several hundred university students from foreign countries are studying in Zimbabwe (see page 49).
- **Well-trained graduated students and scientists from within and abroad:** Zimbabwe has produced well-trained scientists in all fields of science and engineering who are present in the country. Quite a good number are also working at leading research intuitions in the region and internationally. More than 22% of all Zimbabwean university students are completing their undergraduate and postgraduate studies abroad, offering an opportunity to strengthen international research cooperation.
- **Good national infrastructure:** In general, Zimbabwe has a relatively well-developed national infrastructure; it features among the top African countries with a macro-operational capacity that can support a larger SETI agenda. The indicator of gross fixed capital formation (GFCF) shows investment in land improvements (fences, ditches, drains and so on); plant, machinery and equipment purchases; and the construction of roads, railways, air transport, water, telecommunications systems and the like, including commercial and industrial buildings, offices, schools, hospitals and private residential dwellings. According to Figure 5, GFCF increased from a minimum of 2% of GDP in 2005 to 22.4% of GDP in 2012.
- **Abundant natural resources (minerals, flora and fauna):** Zimbabwe is endowed with abundant natural resources; these include rich mineral deposits, arable land, flora and fauna, abundant sunshine and water. These natural resources give Zimbabwe a comparative advantage over other countries. Given the knowledge base and productive resource endowment, the country is projected to be among those leading growth in sub-Saharan Africa by 2020.
- **Generally keen environmental awareness:** environmental awareness is generally high, with an appropriate legislative arsenal which recognizes the need for sustainable development that is protective of the resource base. This is a key asset, given the importance of agriculture, tourism and mining for the country's economic development. Milestones include the Environmental Assessment Act (1994), which makes it mandatory to assess the impact of any development programme before it can be approved, and the Environmental Management Act (2002), which created the Environmental Management Agency to improve co-ordination of the various stakeholders; it formulates quality standards and monitors the observance of these. There is a coherence across different policies, with Zimbabwe's public health system laying emphasis on environmental health and with the country's *Second Science, Technology and Innovation Policy* (Republic of Zimbabwe, 2012a) intending to use R&D to explore both modern and traditional medicines, environmentally sound development programmes and the use of S&T to exploit renewable and non-renewable sources of energy.

- **Exemplary best practices at the University of Zimbabwe:** this university alone was responsible for 58.4% of all the scientific articles published between 1980 and 2013 (see Table 29). The university has a consolidated postgraduate programme providing teacher assistantships to graduate students in order for them to complete their PhDs (see Tables 16 and 17). The institution has the strongest links of any university with the private sector, which is providing funding for several research and innovation projects (see for example page 150); the university is also responsible for advising the government on strategic issues. Most government research centres have formal links with the university. The recent establishment of a subregional graduate programme on SETI policies consolidates the university's pivotal role in developing and implementing a sustainable SETI plan for Zimbabwe.
- **Multidisciplinary network of centres of excellence:** although scientific output is currently dominated by agriculture and health (Figure 27), Zimbabwe disposes of a network of centres of excellence which cover a wide range of specialized areas, including biotechnology, energy technology, remote-sensing, informatics, metallurgic research, meteorology and production engineering. A number of these centres of excellence have experience of public–private partnerships (e.g. Scientific and Industrial Research and Development Centre and National Institute for Health Research. The infrastructure is thus in place to foster SETI for Zimbabwe's socio-economic development, once these institutions benefit from adequate financial and human resources and a regulatory environment conducive to innovation.

Weaknesses

- **Fragility of governance indicators:** having positive values within the indicators of political stability and government effectiveness (see Figure 6) are prerequisites for the effective implementation of SETI policies, or any other public policy for that matter. On the contrary, negative values (see Figures 7 and 8) for both governance indicators promote incoherence and poor co-ordination among the various stakeholders, a lack of FDI and private long-term investments, diminishing national productivity and lead to the possibility of failure to reach the policy goals.
- **Absence of any explicit human resources policy for science and engineering:** there are no specific targets in the *Zimbabwe Agenda for Sustainable Socio-Economic Transformation 2013–2018* for increasing the number of scientists and engineers, or the staffing requirements for industry and other productive sectors (see page 17). The country has only 101 FTE researchers per million of population (2012, see page 53). In agriculture, their number has even decreased from 35 in 1965 to 14 in 2012 (see page 58). The critical mass which triggers innovation on a national scale is at least 1200 FTE researchers per million population (as in China). Developed countries have between 50 and 60 times more FTE researchers than Zimbabwe. There no system of government scholarships in place for completing PhDs in science and engineering, nor any other incentive or policy instrument guaranteeing the promotion of research and innovation. Moreover, despite the fact that only 25% of researchers are women, there no specific gender policy for SETI. In 2013, natural sciences constituted just 8% of total graduates at national level and engineering just 8.8%. There are very few doctoral candidates in SETI. Owing to the poor remuneration package for SETI experts, there are high vacancy rates for SETI posts (teaching and research). As a consequence, there is considerable brain drain in all fields of science and engineering.
- **Inadequate set of operational policy instruments to promote research and innovation:** the GO→SPIN survey has identified only five operational policy instruments. A country the size of Zimbabwe should have between 10 and 20 times more, of a diverse nature and adequately funded. The absence of some of these policy instruments impinges on research and innovation. There is no tax relief from the Zimbabwe Revenue Authority for the importation of research equipment and consumables, or what little relief there is involves such a tedious and long procedure that importers end up paying higher storage charges, which can be equivalent to paying customs duty. There is no adequate legislation to promote innovation and attract FDI and no specific tax incentives or other schemes to promote entrepreneurship and the commercialization of research results. The Innovation and Commercialisation Fund of the Ministry of Higher and Tertiary Education, Science and Technology Development is not being consistently funded (see page 91 and Opportunities overleaf). There are no policy instruments in

place to promote linkages between the SETI demand and supply sides, nor any funding mechanisms addressing the research priorities set up by the Research Council of Zimbabwe (see Box 15) or the *Second Science, Technology and Innovation Policy* (Republic of Zimbabwe, 2012a).

- **Absence of centralized SETI policy formulation and coordination:** the governance structures of institutions responsible for managing SETI are fragmented. The description of the SETI policy cycle reveals a lack of inter-institutional policy formulation and co-ordination (see page xxx). For example, the research priorities proposed by the Research Council of Zimbabwe differ from those formulated by the former Ministry of Science and Technology Development in the *Second Science, Technology and Innovation Policy* (Republic of Zimbabwe, 2012a), which in turn differ from the research and innovation policies proposed independently by the Ministries of Industry and Commerce; Health and Child Care; Environment, Water and Climate; Energy and Power Development and; Mines and Mining Development. The lack of co-ordination generates duplication, an absence of synergies and inefficiencies; it makes it impossible to reach all the different goals and increases transaction and bureaucratic costs. The cross-cutting nature of SETI activities requires having a specific national body with overall responsibility for co-ordinating the policy formulation, design, implementation, funding and assessment of all research and innovation in the country. This type of body usually relies on an interministerial structure like the former Cabinet Committee on Scientific Research, Technology Development and Application, the mandate of which included the design, approval and assessment of a more holistic and integrated national SETI plan and follow-up to monitor implementation.
- **Low research and innovation productivity:** with only 0.26 scientific articles per FTE researcher published in mainstream journals (c. 2012), the number of articles per million inhabitants has remained constant in Zimbabwe since independence, at around 25. This is 170 times smaller than the productivity of Switzerland, 13 times smaller than that of Tunisia and six times smaller than that of Botswana, to cite just a few examples. The past decade has seen an extraordinary increase in the number of co-publications with foreign countries, which now represent 75–80% of all Zimbabwean scientific articles listed at the Web of Science (see Figure 26). The lack of any correlation between scientific publications per capita and GDP per capita (see Figure 25) in Zimbabwe, unlike in most other countries (see Lemarchand, 2012; UNESCO, 2013), is an indication of the absence of policy instruments for promoting scientific research. In recent decades, 40 % of publications were in medical sciences, 25% in natural sciences, 25% in agricultural sciences and just 5% in engineering, even though the latter is the major driver of innovation. In comparison, in the emerging economies of China and the Republic of Korea, where there are linkages between research and innovation, 80% of all publications are in natural sciences and/or engineering. As for patents, the past five decades has seen a continual decrease in the number of applications by residents (and non-residents), from a few hundred to a handful per year (see Figure 28).
- **A small SETI demand sector:** real growth in Zimbabwe's manufacturing sector has been slowing since 2011. Manufacturing grew by 14% in 2011, 2.3% in 2012 and 1.5% in 2013. Average capacity utilization has also been falling, from 57.2% in 2011 to 29.6% in 2013. These macro-economic conditions hamper research and innovation in the business and enterprises sector (SETI demand side). In developed and emerging economies, the business sector provides between 50% and 70% of national gross expenditure on research and development. In this way, the SETI demand side tracks the type of research done at the governmental research centres and higher education institutions (SETI supply side). The lack of any tax incentives to promote innovation and the absence of any other policy instrument to foster networking between the government and university sectors is one of the country's biggest weaknesses.
- **Indigenous knowledge remains largely disregarded:** knowledge is the key input to innovation. It can come from a formal process, such as R&D, but also in the form of indigenous knowledge developed over centuries of learning from the environment. Indigenous knowledge can play a central role in transforming and modifying technologies to suit local conditions and the local context, as well as in developing indigenous home-grown technologies. To play that role, indigenous knowledge needs to be documented, protected and efficiently managed. Zimbabwe needs to incorporate indigenous knowledge in the formulation of R&D strategies. There is scant input from indigenous knowledge in the *Second Science, Technology and Innovation Policy* (Republic of Zimbabwe, 2012a).

Opportunities

- **Human capital development in science and engineering:** Zimbabwe's population is dominated by youth who are eager to study and develop their potential. There is an opportunity to train young people in science and engineering, by putting in place adequate SETI policy instruments to provide incentives like scholarship programmes to encourage students to embark on a PhD and a system of competitive grants for young researchers in those priority fields determined by national policies. The *Second Science, Technology and Innovation Policy* (Republic of Zimbabwe, 2012a) proposes a strategic threshold of 60% of university education being oriented towards promoting S&T skills development. Schools should have well-equipped science laboratories and be resourced with science and mathematics teachers to encourage students to study science and mathematics at secondary school then SETI programmes at university.
- **Improve gender equality in science and engineering:** gender equality is one of the eight United Nations Millennium Development Goals, which clearly call for action related to science, technology and gender. By introducing appropriate SETI policy instruments and incentives, both in the education system (from primary school to university postgraduate studies) and in the terms of reference of advertised posts or calls for research and innovation proposals, it will be possible to improve the participation of women in science and engineering.
- **Universities with SETI programmes:** Zimbabwe has established four state universities since 1991 focusing on science, engineering and technology, namely the National University of Science and Technology (established in 1991), Bindura University of Science Education (est. 2000), Chinhoyi University of Technology (est. 2001), and Harare Institute of Technology (est. 2005). Two more universities are in the pipeline which will focus on agricultural science and technology: Marondera State University and Manicaland State University. This demonstrates the government commitment to SETI and, as long as these universities are well-resourced, they should contribute to the country's socio-economic transformation.
- **National, regional and international collaboration:** appropriate policy instruments and special mechanisms can be designed to promote synergies and networking among national laboratories, universities and the manufacturing sector. Other policy instruments should improve the participation of the diaspora in strategic research and innovation projects in Zimbabwe, in tandem with the amelioration of national networking between public and private research institutions and enterprises. There are many PhD holders in Zimbabwe and beyond working in, and heading, research institutions. Collaboration and networking in research and innovation both among those within and without Zimbabwe can lead to a better higher education system, greater scientific productivity and stronger linkages between the SETI supply and demand sides.
- **Research and innovation funding agency:** an independent funding agency could promote research and innovation by acting as a catalyst for the implementation of national strategic SETI objectives. Such an agency could administer one or more national funds, such as the Innovation and Commercialisation Fund (see page xxx), by implementing a series of operational policy instruments such as: competitive grants and scholarships, loans for technological developments, levies (to raise funds), fiscal credits for innovation, seed funds, venture capital, instruments for internationalizing small and medium-sized enterprises, etc. Intersectorial co-ordination could be improved by centralizing research and innovation funding for all the line ministries (such as the Ministries of Higher and Tertiary Education, Science and Technology Development; Industry and Commerce; Health and Child Care; Environment, Water and Climate; Energy and Power Development; Mines and Mining Development).
- **Value-addition to abundant natural resources:** value-addition across all sectors in Zimbabwe remains low. Zimbabwe is still a net exporter of raw materials. There is a wide margin for manoeuvre for using SETI to add value across sectors (agriculture, timber, mining, textile, leather, etc.) and for using innovation to add value to Zimbabwe's abundant natural resources.

- **Improvement of infrastructure to support SETI activities:** a robust infrastructure network and system plays a fundamental role in the socio-economic development of Zimbabwe. To this end, through the *Zimbabwe Agenda for Sustainable Socio-Economic Transformation 2013–2018*, the government will rehabilitate, upgrade and develop the national power grid, road and railway network, water storage, supply and sanitation, buildings as well as ICT-related infrastructure (see also page 17).

Threats

- **Low uptake and pass rate in science subjects:** Zimbabwe does not have a concerted educational system from primary, secondary and tertiary levels of education focusing on scientific and technical training. Secondary school education in the sciences has a major impact on the nation's opportunities to engage in a meaningful agenda for SETI. Just 5.7% of the students enrolled in mathematics at ordinary level went on to study the same subject at advanced level in the past decade (see Tables 12 and 13). Moreover only 9.5% of candidates passed five or more ordinary level subjects in 2012, including mathematics and science (see Figure 15 and Table 14). The failure rate in mathematics is of concern, since mathematics is a key subject in most science, engineering and technological training programmes. While university enrolment in general has improved as a consequence of the increase in the number of universities in the country, enrolment in SETI- related programmes remains very low compared to enrolment in social sciences and commercial fields.
- **High dependence on state funding:** the research institutions and universities have traditionally depended heavily on government research grants, which dwindled from 2000 onwards when the economy began performing badly. There is a need to improve the participation of private research funding and international co-operation.
- **Low participation of the business/enterprise sector in R&D:** linkages between universities, R&D centres and the business/enterprise sector are very weak. With the exception of the tobacco industry (see Box 9) and other specific agriculture-oriented cases, there has traditionally been weak collaboration between industry and academia in Zimbabwe. There is an absence of appropriate policy instruments and tax incentives to promote innovation in the business and enterprise sector, or stimulate a strong interaction between the SETI supply and demand sides. Without more systematic public support for innovation policies within the private sector, it will be impossible to commercialize research results effectively, even though this is one of the major goals of the country's *Second Science, Technology and Innovation Policy* (Republic of Zimbabwe, 2012a).
- **Poor co-ordination, monitoring and evaluation:** research centres, technical universities, colleges and some manufacturing entities have workshops and laboratories that are under-utilized and under-equipped, owing to a lack of co-ordination, communication and publicity.
- **An erratic energy supply is derailing progress in SETI:** power-cuts which occur in the middle of either a research experiment or new technological development or during implementation of a critical innovation in a factory can disrupt activity and erode the morale of scientists and entrepreneurs. This is compounded by low internet connectivity and reliability.
- **Regional competition:** most trained scientists and engineers are migrating to neighbouring countries which can offer better working conditions, access to well-equipped labs and a good remuneration. The poor performance of Zimbabwe's economy makes it very difficult to retain new PhD degree holders.
- **The wealth of SETI strategic priorities dilutes policy effectiveness:** the S*econd Science, Technology and Innovation Policy* (Republic of Zimbabwe, 2012a) proposes six primary goals. An analysis of their content (see page 100) reveals that there are, in fact, seven different strategic priorities. Taking into consideration the priorities set by the Research Council of Zimbabwe and the sectorial research and innovation priorities proposed by other ministries (see Weaknesses above) actually inflates this number. The absence of adequate operational policy instruments and the scarce funding allocation may endanger the smooth implementation and effectiveness of the proposed policies.

Table 46: SWOT analysis of Zimbabwe's research and innovation system

Strengths	Weaknesses
• Pioneering institutional background in Africa for research and innovation • High literacy rate • Well-developed education system • Well-trained graduated students and scientists from within and abroad • Good national infrastructure • Abundant natural resources (minerals, flora and fauna) • Generally keen environmental awareness • Exemplary best practices at the University of Zimbabwe • Multidisciplinary network of centres of excellence	• Fragility of governance indicators • Absence of any explicit human resources policy for science and engineering • Inadequate set of operational policy instruments to promote research and innovation • Absence of centralized SETI policy formulation and coordination • Low research and innovation productivity • A small SETI demand sector • Indigenous knowledge remains largely disregarded

Opportunities	Threats
• Human capital development in science and engineering • Improve gender equality in science and engineering • Universities with SETI programmes • National, regional and international collaboration • Research and innovation funding agency • Value-addition to abundant natural resources • Improvement of infrastructure to support SETI activities	• Low uptake and pass rate in science subjects • High dependence on state funding • Low participation of the business/enterprise sector in R&D • Poor coordination, monitoring and evaluation • An erratic energy supply is derailing progress in SETI • Regional competition • The wealth of SETI strategic priorities dilutes policy effectiveness

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Glossary

I. Glossary of main terms used in R&D surveys

The *National Survey of Research and Development* conducted in Zimbabwe in 2013 used a series of definitions proposed by UNESCO (1978, 1982; 1984ab; 1988), the UNESCO Institute for Statistics (2010) and OECD (2002) which have been adopted by the African Science, Technology and Innovation Indicators (ASTII) initiative to standardize the collection of R&D statistics in Africa. In order to interpret the main findings of the Zimbabwean survey accurately, we present a selection of the most relevant definitions here.

Sectors covered by R&D surveys

Business enterprise sector: (a) all firms, organizations and institutions whose primary activity is the market production of goods or services (other than higher education) for sale to the general public at an economically significant price, including both public and private enterprises; (b) the private non-profit institutions mainly serving them.

Government sector: (a) all departments, offices and other bodies which furnish, but normally do not sell to, the community, those common services, other than higher education, which cannot otherwise be conveniently and economically provided, as well as those that administer the state and the community's economic and social policy; (b) public enterprises mainly engaged in market production and the sale of goods and services are included in the business enterprise sector; (c) non-profit institutions controlled and mainly financed by government, not administered by the higher education sector.

Higher education sector: (a) all universities, colleges of technology and other institutions providing tertiary education (see below for details), whatever their source of finance or legal status; (b) all research institutes, experimental stations and clinics operating under the direct control of, or administered by, or associated with, higher education institutions.

Private non-profit sector: (a) Non-market, private non-profit institutions serving households (i.e. the general public) and (b) private individuals or households.

Definition of research and experimental development

Research and experimental development (R&D): comprises creative work undertaken on a systematic basis, in order to increase the stock of knowledge, including knowledge of humanity, culture and society, and the use of this stock of knowledge to devise new applications. The term R&D covers three activities: basic research, applied research and experimental development.

Basic (or fundamental) research: is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view.

Applied research: is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective.

Experimental development: is systematic work, drawing on existing knowledge gained from research and/or practical experience, which is directed towards producing new materials, products or devices, towards installing new processes, systems and services, or towards improving substantially those already produced or installed. R&D covers both formal R&D in R&D units and informal or occasional R&D in other units.

Definition of personnel

R&D personnel: all persons employed directly in R&D, as well as those providing direct services such as R&D managers, administrators and clerical staff. Persons providing an indirect service, such as canteen and security staff, should be excluded.

Head count: data reflect the total number of persons employed in R&D, independently of the focus of their work. These data allow links to be made with other data series, such as education and employment data, or the results of population censuses. They also serve as the foundation for calculating indicators which analyse the characteristics of the R&D labour force, with respect to age, gender or national origin.

Full-time equivalent (FTE): may be thought of as one person-year. Thus, a person who normally spends 30% of his/her time on R&D and the rest on other activities (such as teaching, university administration and student counselling) should be considered as 0.3 FTE. Similarly, if a full-time R&D worker is employed at an R&D unit for only six months, this results in an FTE of 0.5. However, for reporting purposes, the total sum of FTEs should be rounded to the next integer to avoid the reporting of decimals.

Researchers: are professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and also in managing the projects concerned. Postgraduate students at the PhD level engaged in R&D should be considered as researchers.

Technicians: and equivalent staff are persons whose main tasks require technical knowledge and experience in one or more fields of engineering, physical and life sciences (technicians) or social sciences and humanities (equivalent staff). They participate in R&D by performing scientific and technical tasks involving the application of concepts and operational methods, normally under the supervision of researchers.

Support staff: includes skilled and unskilled craftsmen, secretarial and clerical staff participating in R&D projects or directly associated with such projects (or providing services to researchers involved therein).

International Standard Classification of Education (ISCED) levels

UNESCO developed the International Standard Classification of Education (ISCED) to facilitate comparisons of education statistics and indicators across countries on the basis of uniform and internationally agreed definitions.

The ISCED levels that were in use at the time of the Government of Zimbabwe's 2013 *National Survey of Research and Innovation* were those from the 1997 revision of ISCED levels, namely:

ISCED 6 programmes: tertiary programmes leading to the award of an advanced research qualification. The programmes are therefore devoted to advanced study and original research and are not based on coursework only. They typically require the submission of a thesis or

dissertation of publishable quality which is the product of original research and represents a significant contribution to knowledge. They usually prepare graduates for faculty posts in institutions offering ISCED 5A programmes, as well as research posts in government, industry, etc.

ISCED 5A programmes: tertiary programmes that are largely theoretically based and are intended to provide sufficient qualifications for gaining entry into advanced research programmes and professions with high skills requirements. They must satisfy a sufficient number of the following criteria: (a) a minimum cumulative theoretical duration (at tertiary) of three years' full-time equivalent, although typically they are of four or more years; (b) faculty with advanced research credentials; (c) may involve completion of a research project or thesis; (d) provide the level of education required for entry into a highly skilled profession (theoretically based/research preparatory, such as history, philosophy, mathematics, etc., or giving access to highly skilled professions, e.g. medicine, dentistry, architecture, etc.) or an advanced research programme. This level includes all the research programmes which are not part of a doctorate, such as any type of master's degree.

ISCED 5B programmes: are tertiary programmes which are typically shorter than those in 5A and focus on giving participants occupational skills and a relevant qualification for the labour market, although some theoretical foundations may be covered. The content of ISCED level 5B programmes is mainly designed to give participants the practical skills and know-how needed for employment in a particular occupation or trade, or class of occupations or trades.

ISCED 4 programmes: are post-secondary, non-tertiary education programmes that straddle the boundary between upper-secondary and post-secondary education from an international point of view, even though they might clearly be considered as upper-secondary or post-secondary programmes in a national context. ISCED 4 programmes cannot, considering their content, be regarded as tertiary programmes. They are often not significantly more advanced than programmes at ISCED 3 level but they serve to broaden the knowledge of participants who have already completed a programme at level 3. Typical examples are programmes designed to prepare students for studies at level 5 who have completed ISCED 3 but did not follow a curriculum which would allow entry to level 5, i.e. pre-degree foundation courses or short vocational programmes. Second-cycle programmes can be included as well.

ISCED 3 programmes: are (upper) secondary education programmes typically beginning at the end of full-time compulsory education for those countries that have a system of compulsory education. The entrance age to this level is typically 15 or 16 years. The educational programmes included at this level typically require the completion of some nine years of full-time education (since the beginning of level 1) for admission, or a combination of education and vocational or technical experience, with, as minimum entrance requirements, the completion of level 2 or a demonstrable ability to handle programmes at this level.

The new International Standard Classification of Education

In 2011, UNESCO member states formally adopted a revision of ISCED. The product of extensive international and regional consultations among education and statistical experts, ISCED 2011 takes into account significant changes in education systems worldwide since the last ISCED revision of 1997.

ISCED 2011 counts four levels of tertiary education, as compared to two in the current version. The aim of the revision is to reflect the tertiary education structure found around the world better (bachelor's, master's and doctorate). This structure has been generalized across Europe since the Bologna Process got under way in 1999.

The first data collection based on the new classification began in 2014. The UNESCO Institute for Statistics is working closely with Member States and partner organizations (such as OECD and Eurostat) to map education systems using the new classification and revise statistic-gathering instruments.

The four new levels of tertiary education (effective as of 2014) are:

ISCED level 5 – Short-cycle tertiary education;

ISCED level 6 – Bachelor's degree or equivalent level;

ISCED level 7 – Master's degree or equivalent level;

ISCED level 8 – Doctoral or equivalent level.

Source: UNESCO Institute for Statistics (UIS) - UIS/RD/2012M
For details of ISCED 2011, see: www.uis.unesco.org/Education/Documents/isced-2011-en.pdf

II. Glossary on intellectual property rights

Applicant: An individual or other legal entity that files an application for a patent, utility model, trademark or industrial design. There may be more than one applicant in an application. For the statistics presented in the present publication, the name of the first-named applicant is used to determine the owner of the application.

Application abroad: For statistical purposes, an application filed by a resident of a given state/jurisdiction with an IP office of another state/jurisdiction. For example, an application filed by an applicant domiciled in France with the Japan Patent Office (JPO) is considered an 'application abroad' from France's perspective. This differs from a 'non-resident application', which describes an application filed by a resident of a foreign state/jurisdiction from the perspective of the office receiving the application.

Industrial design: applies to a wide variety of industrial products and handicrafts. It refers to the ornamental or aesthetic aspects of a useful article, including compositions of lines or colours or any three-dimensional form that gives a special appearance to a product or handicraft. The holder of a registered industrial design has exclusive rights concerning unauthorized copying or imitation of the design by third parties. Industrial design registrations are valid for a limited period. The term of protection is usually 15 years for most jurisdictions. However, differences in legislation do exist, notably in China (which provides for a 10-year term from the application date) and the USA (which provides for a 14-year term from the date of registration).

Intellectual property (IP): refers to creations of the mind: inventions, literary and artistic works, symbols, names, images and designs used in commerce. IP is divided into two categories: industrial property, which includes patents, utility models, trademarks, industrial designs and geographical indications of source; and copyright, which includes literary and artistic works such as novels, poems and plays, films, musical works, artistic works such as drawings, paintings, photographs, sculptures and architectural designs. Rights related to copyright include those of performing artists in their performances, producers of phonograms in their recordings and those of broadcasters in their radio and television programmes.

Invention: a new solution to a technical problem. To obtain patent rights, the invention must be novel, involve an inventive step and be industrially applicable, as judged by a person skilled in the art.

Non-resident: for statistical purposes, a 'non-resident' application refers to an application filed with the IP office of, or acting for, a state/jurisdiction in which the first-named applicant in the application is not domiciled. For example, an application filed with the JPO by an applicant residing in France is considered a non-resident application from the perspective of this office. Non-resident applications are sometimes referred to as foreign applications. A non-resident grant or registration is an IP right issued on the basis of a non-resident application.

Patent: a set of exclusive rights granted by law to applicants for inventions that are new, non-obvious and commercially applicable. It is valid for a limited period of time (generally 20 years), during which patent holders can commercially exploit their inventions on an exclusive basis. In return, applicants are obliged to disclose their inventions to the public in a manner that enables others, skilled in the art, to replicate the invention. The patent system is designed to encourage innovation by providing innovators with time-limited exclusive legal rights, thus enabling innovators to appropriate a return on their innovative activity.

Patent Cooperation Treaty (PCT): an international treaty administered by WIPO. The PCT system facilitates the filing of patent applications worldwide and makes it possible to seek patent protection for an invention simultaneously in each of a large number of countries by first filing

a single 'international' patent application. The granting of patents, which remains under the control of the national or regional patent offices, is carried out in what is called the 'national phase' or 'regional phase'.

Registration: a set of exclusive rights legally accorded to the applicant when an industrial design or trademark is 'registered' or 'issued'. (See also Industrial design or Trademark.) Registrations are issued to applicants so that they can make use of, and exploit, their industrial design or trademark for a limited period of time; in some cases, registration can be renewed indefinitely, particularly in the case of trademarks.

Resident: for statistical purposes, a 'resident' application refers to an application filed with the IP office of, or acting for, the state/jurisdiction in which the first-named applicant in the application has residence. For example, an application filed with the JPO by a resident of Japan is considered a resident application from the perspective of the JPO. Resident applications are sometimes referred to as domestic applications. A resident grant/registration is an IP right issued on the basis of a resident application.

Trademark: a distinctive sign that identifies certain goods or services as those produced or provided by a specific person or enterprise. The holder of a registered trademark has the legal right to exclusive use of the mark in relation to the products or services for which it is registered. The owner can prevent unauthorized use of the trademark, or a confusingly similar mark, so as to prevent consumers in particular and the public in general from being misled. Unlike patents, trademarks can be maintained indefinitely by paying renewal fees. The procedures for registering trademarks are governed by the rules and regulations of national and regional IP offices. Trademark rights are limited to the jurisdiction of the authority that registers the trademark. Trademarks can be registered by filing an application at the relevant national or regional office(s), or by filing an international application through the Madrid system.

Utility model: a special form of patent right granted by a state/jurisdiction to an inventor or the inventor's assignee for a fixed period of time. The terms and conditions for granting a utility model differ slightly from those for normal patents (including a shorter term of protection and less stringent patentability requirements). The term 'utility model' can also describe what are known in some countries as 'petty patents', 'short-term patents' or 'innovation patents'.

Source: WIPO (2013)

Zimbabwe founded its first research facilities more than a century ago. It has relatively well-developed national infrastructure and a long-standing tradition of promoting research and development (R&D), as evidenced by the levy imposed on tobacco-growers since the 1930s to promote market research.

The country also has a well-developed education system, with one in eleven adults holding a tertiary degree. Given the country's knowledge base and abundant natural resources, Zimbabwe has the potential to figure among the countries leading growth in sub-Saharan Africa by 2020.

To do so, however, Zimbabwe will need to correct a number of structural weaknesses. For instance, it currently lacks the critical mass of researchers needed to trigger innovation. Although the infrastructure is in place to harness R&D to Zimbabwe's socio-economic development, universities and research institutions lack the requisite financial and human resources to conduct R&D and the current regulatory environment hampers the transfer of new technologies to the business sector. Nor does the current development agenda to 2018 contain any specific targets for increasing the number of scientists and engineers, or the staffing requirements for industry and other productive sectors. To compound matters, the lack of co-ordination and coherence among governance structures has led to a multiplication of research priorities and poor implementation of existing policies.

The Government of Zimbabwe is conscious of the fact that it will be unable to redress the economy and durably improve the population's living standards, unless it manages to correct these structural weaknesses. In 2013, it appealed for UNESCO's assistance in preparing an evidence-based policy analysis of its particular situation. The present profile of science, technology and innovation in Zimbabwe has been produced within UNESCO's Global Observatory of Science, Technology and Innovation Policy Instruments (GO→SPIN), a relatively new UNESCO initiative which stresses the importance of having a wide range of policy instruments to ensure effective policy implementation. GO→SPIN is applying a new methodology to mapping research and innovation at country level, in order to inform the reform process and improve monitoring of national innovation systems.

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