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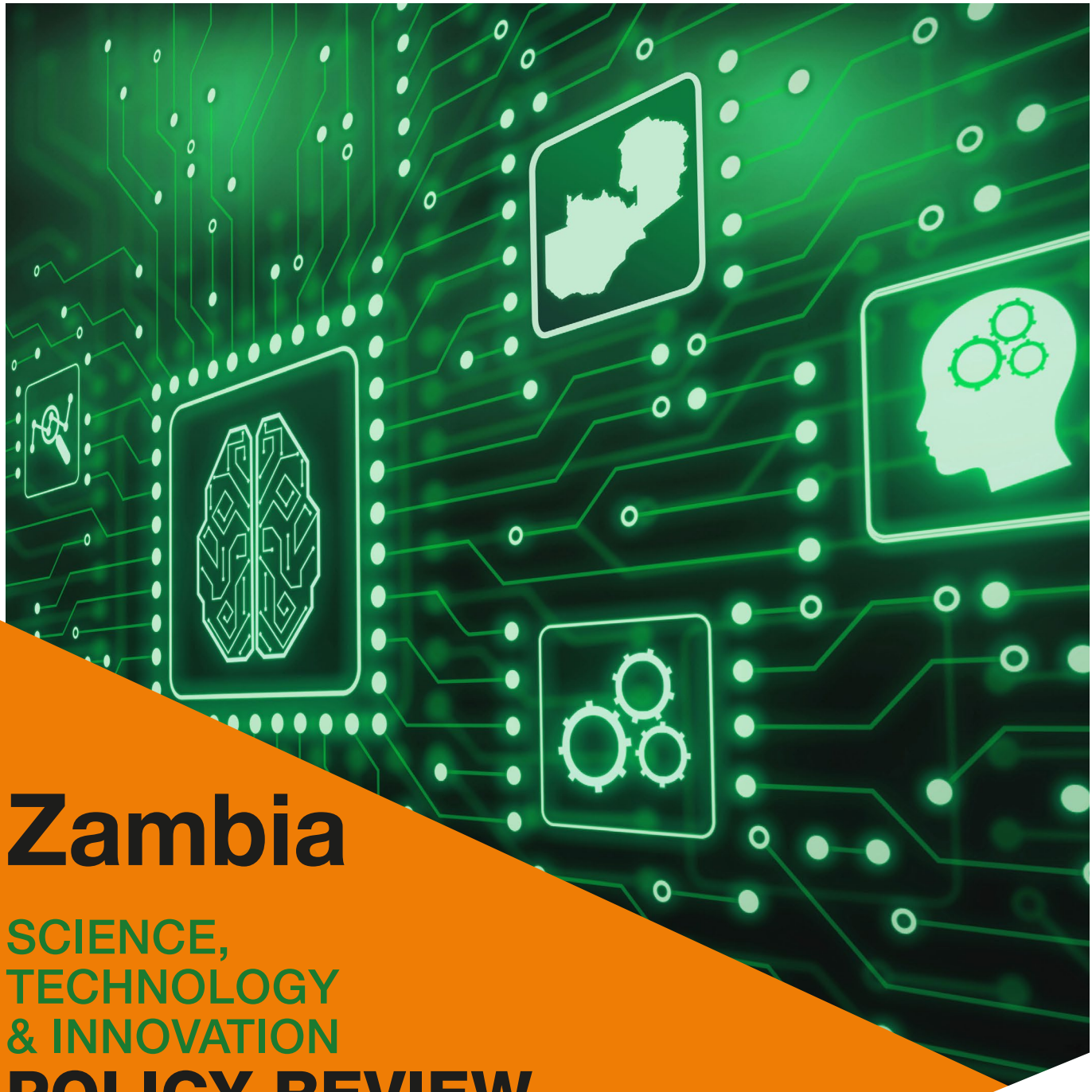

Zambia

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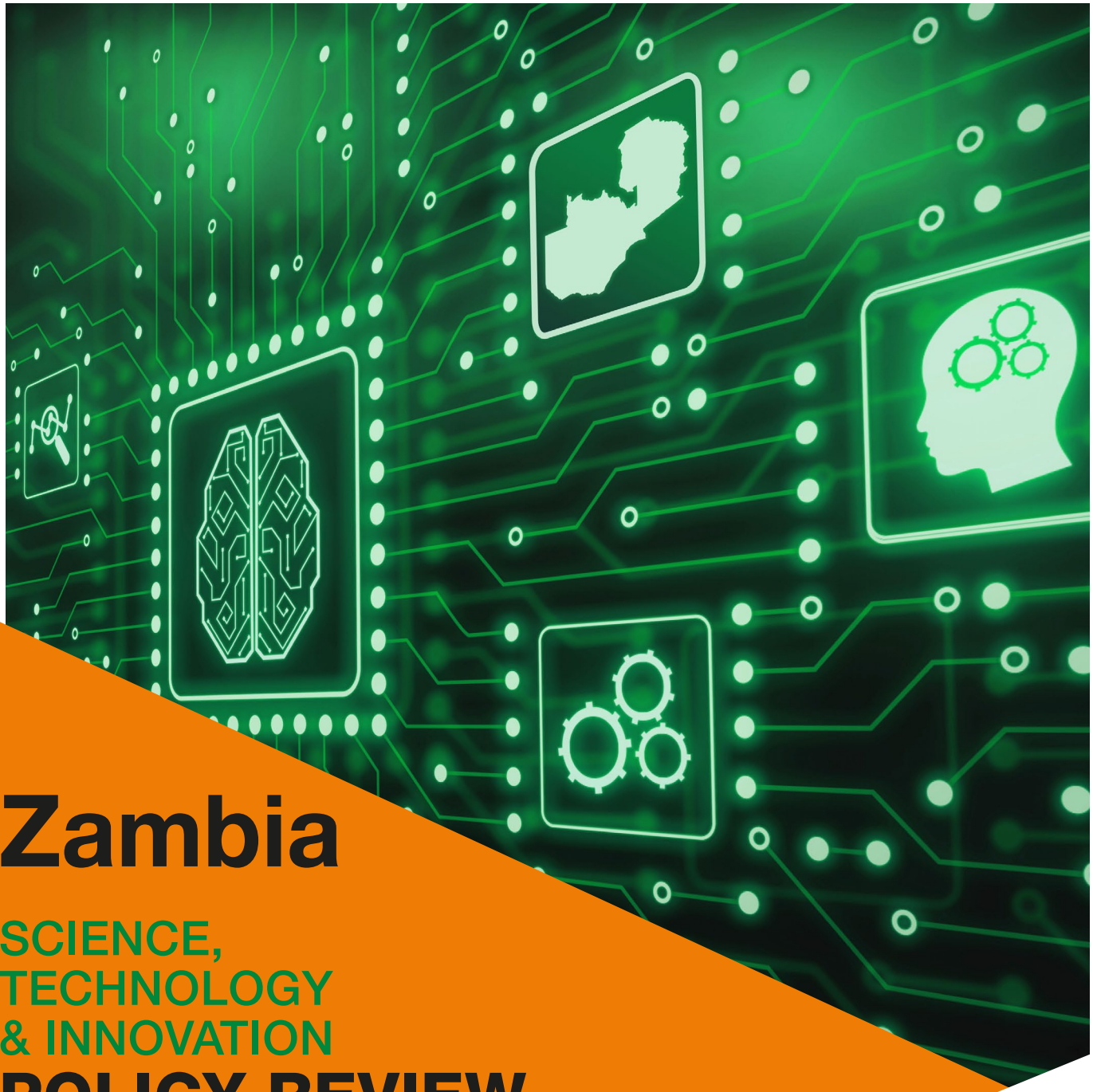

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SCIENCE, TECHNOLOGY & INNOVATION POLICY REVIEW

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Note

The following symbols have been used in the tables:

- Two dots (..) indicate that data are not available or not separately reported. Rows in tables have been omitted in those cases where no data are available for any of the elements in the row.
- A hyphen (-) indicates that the item is equal to zero or its value is negligible.
- A slash (/) between dates representing years – for example 2018/19 indicates a financial year.
- Use of an en dash (–) between dates representing years (for example: 2008–2010) signifies the full period involved, including the beginning and end years.
- Reference to “dollars” ($) means United States dollars, unless otherwise indicated.
- Annual rates of growth or change, unless otherwise stated, refer to annual compound rates.
- Details and percentages in tables may not necessarily add to totals because of rounding.

Preliminary remarks

This Science, Technology and Innovation (STI) Policy Review was prepared by UNCTAD at the request of the Ministry of Higher Education of Zambia.

As the focal point in the United Nations system for the integrated treatment of trade and interrelated issues of finance, technology, investment and sustainable development, UNCTAD supports member States in these areas through a combination of consensus-building, policy analysis and technical cooperation. Within this framework, the objective of this Review is to contribute to the development of national capacities for design and implementation of science, technology and innovation policies, plans and programmes. Such activities aim to improve the competitiveness of firms and industries in a global economy in which knowledge is an increasingly important factor. They also target the Sustainable Development Goals (SDGs) to secure a more inclusive and sustainable development path, in the understanding that science, technology and innovation are critical means of implementation of the Agenda for Sustainable Development embodied by the SDGs. This review is intended to be a tool for learning and reflection. It is not a rating mechanism but an analytical instrument which examines key elements of the national innovation system from a neutral perspective.

The Review has three fundamental goals. Its first goal is to offer Zambia an assessment of activities and institutions that make up its innovation ecosystem. The second goal is to draw attention to important socio-economic development questions for Zambia. Special attention has been placed on four such questions: gender, food, mining and digital transformation. The third goal is to provide recommendations for strengthening STI policy and propose measures that may improve national technological capacities and encourage innovation.

During UNCTAD's missions to Zambia in 2019 and 2020, the STI Policy Review team held interviews and meetings with more than seventy representatives of government agencies, research institutes, universities, chambers of commerce and businesses. The Review has been informed by quantitative data acquired from national and international sources.

This review would not have been possible without the cooperation of the Ministry of Higher Education and, in particular, Honourable Minister Dr. Brian Mushimba and Permanent Secretary Kayula Siame. A special appreciation is owed to the Ministry's Science, Technology and Innovation department. Since the draft of this review was completed in July 2021, the ministerial oversight of STI matters has been entrusted to the new Ministry of Technology and Science, where the Department of Science, Technology and Innovation was re-established.

The finalization of this review took place during both an election year and the Covid-19 crisis. These events curtailed opportunities to review and exchange perspectives at various phases of the drafting process. As a result, the descriptions and assessments in this review are strictly those of the UNCTAD staff experts and consultants. Notwithstanding, there is a high level of confidence that expressed views largely coincide with the perspectives of policymakers, experts and partners in Zambia, who have been gracious with their time and support during the UNCTAD missions and follow-up discussion, including during the 2020 and 2021 sessions of the UN Commission on Science and Technology for Development.

While national partners, counterparts and experts in Zambia have advised on its content, they may not necessarily concur with the entirety of the Science, Technology and Innovation Policy Review's analysis and recommendations. The data cited in the Review is established by UNCTAD research staff. The assessments, opinions and conclusions expressed in this document are entirely those of the UNCTAD secretariat.

Abbreviations

CEO	Chief executive officer
CFU	Conservation Farming Unit
DC	Direct current
EXIM	Export-import
FDI	Foreign direct investment
FISP	Farmer Input Support Programme
GCF	Green Climate Fund
GDP	Gross domestic product
GII	Global Innovation Index
HDI	Human Development Index
HEA	Higher Education Authority
ICT	Information and communication technologies
IDC	Industrial Development Corporation
IMF	International Monetary Fund
IoT	Internet of things
IP	Intellectual property
IPRs	Intellectual property rights
MCTI	Ministry of Commerce Trade and Industry
MDG	Millennium Development Goals
MMMD	Ministry of Mines and Minerals Development
MOH	Ministry of Health
MoHE	Ministry of Higher Education
NAPSA	National Pension Scheme Authority
NCSR	National Council for Scientific Research
NDP	National Development Plan
NISIR	National Institute for Scientific and Industrial Research
NRSC	National Remote Sensing Centre
NSI	National system of innovation
NSTC	National Science and Technology Council
NTBC	National Technology Business Council
PACRA	Patents and Companies Registration Agency
PPP	Purchasing power parity
R&D	Research and development
SDG	Sustainable Development Goals
SHS	Solar home systems
SME	Small- and medium-sized enterprise
STEM	Science, technology, engineering and mathematics
STI	Science, technology and innovation
TBDF	Technology Business Development Fund
TVET	Technical and vocational education and training
TVETA	Technical Education, Vocational and Entrepreneurship Training Authority
UN	United Nations
UNCDF	United Nations Capital Development Fund
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development
WIPO	World Intellectual Property Organization
ZaAS	Zambia Academy of Sciences
ZaBS	Zambia Bureau of Standards
ZARI	Zambian Agricultural Research Institute
ZICTA	Zambia Information and Communications Technology Authority
ZMW	Zambian Kwacha

Contents

List of figures

List of boxes

List of tables

Key messages

General observations

The achievement of Zambia's Vision 2030 will depend on spurring innovation in firms and industries, developing financial support for science, technology and innovation (STI) activities, and strengthening the education system.

To effectively harness STI for development, Zambia will need to strengthen the implementation of STI policies and boost its STI capabilities. The key challenge will be to strengthen policy coordination and political visibility for STI, with particular emphasis on the innovation element of the science-technology-innovation triad.

The COVID-19 pandemic has weakened Zambia's capacity to respond to the pressing challenges in STI and in achieving the Sustainable Development Goals (SDGs) more generally. Recovery strategies will need to allocate resources and policy attention to nurturing and strengthening the actors in the national innovation system and enabling their interactions.

Development challenges and STI

Growing economies and dynamic markets provide more opportunities for innovative firms. Growth in Zambia shows positive trends, but its demography limits per capita outcomes while income inequalities curtail demand for STI. Relatively high unemployment, particularly among the youth, drives necessity rather than opportunity-based entrepreneurship, which rarely presents significant technology content.

SDGs that are closely tied to aggregate economic performance show positive development while STI provides important opportunities for sustained improvements. However, economic transformation remains slow, indicating a low impact of STI. Changes of sector contributions to GDP and employment do not affect national welfare as agricultural jobs are replaced with equally low-productivity jobs in services.

Economic diversification is fundamental to accelerating development in Zambia. However, diversification is heavily dependent on STI, which has low policy visibility. To effectively place Zambia on a trajectory of economic diversification, policymakers will need to embrace the idea that STI is one of the principal sources of economic diversification and job creation, of productivity improvement and economic growth.

STI policies and initiatives

The 2020 STI Policy has been promulgated after a decade of discussions and consultations. The key challenge is securing budgetary support and effective implementation under conditions of limited capacities. Policymakers also need to develop an effective operational framework to introduce STI policy goals and measures into the Eight National Development Plan (NDP8) and, by consequence, undertake actions for successful implementation.

The need for more coordination is particularly important for an STI Policy with very limited resources. The institutional system has not changed compared to previous policy cycles. Four STI agencies are active in Zambia but funding remains modest. When financial support is made available to innovative firms and entrepreneurs, there are few takers willing to engage. To remedy this situation, application requirements for funding need to better match the realities, interests, capacities and aspirations of firms and entrepreneurs.

Key ancillary services for innovation such as intellectual property, metrology, testing and quality services are present and well recognized in Zambia with two fully operational and active agencies. Intellectual property practice shows a bias towards trademark registrations and relatively few filings for industrial design and patents. This in line with expectations from an economy with modest innovation.

The performance of Zambia's innovation system

Using the Global Innovation Index (GII) as a benchmark, the decline in rank of Zambia indicates a need for stronger STI policy action to activate transformative processes. It should be noted that Zambia ranks higher in innovation inputs than in innovation outputs, suggesting that STI actors struggle to translate science and technology into innovation.

The overall condition of the business environment is a key precondition for innovation given that most innovation happens in firms and industries. Here, Zambia has a positive score on several elements that

can be leveraged. At the same time, it must be noted that while parastatals have modest innovative drive, privatization shows that private ownership and private interest is also not a sufficient driver for innovation.

Stronger linkages between academia and industry need to tap the national knowledge base and prepare Zambia's youth to respond to the needs of a more diversified and innovative economy. This requires collaboration among diverse government entities to draw in academia and industry and exploit common ground and synergies.

Education is a major input into developing national capacity for STI-led development. Zambia has made important progress in school enrolment at all levels during the last two decades. However, the technical and vocational education and training (TVET) system will require scaling up to provide a qualified and productive workforce for increasingly technological development in services and industry.

Zambia has long-standing and reputable universities. To increase their contribution as an actor in the national system of innovation, universities will need to improve the work-readiness of their graduates and engage more profoundly with firms and industries on both training and research agendas.

Challenges of STI governance

Since its independence in 1964, Zambia's peaceful political climate and democratic foundations have helped it forge its way through important socio-economic challenges and will continue to do so. However, Zambian policymakers and STI stakeholders need to create a sense of urgency around the STI agenda. Improving the visibility for STI in the development agenda is imperative.

STI policy perspectives will need to move from a linear science-push paradigm, to one that takes the perspective of the national system of innovation and seeks to stimulate demand for STI. Stronger implementation capacity is needed to enable STI policy to effectively address Zambia's key SDGs and development aspirations. Institutions and governance mechanisms are in place and can support determined decisions and actions. STI stakeholders will need to embrace and actively perform their roles in the NSI.

Policy recommendations

To raise the status of STI policy in government, policymakers need to better articulate the role that STI can play for the medium- and long-term development of the country. They may need to establish an authority for STI attached to the President and above the level of Minister as well as a liaison committee on STI matters at the level of the Permanent Secretaries of all concerned ministries. An inter-ministerial group needs to be established to develop a strategy and mechanism to ensure a more effective integration of STI mandates and actions within the national planning process for NDP8.

Zambia's STI capacity in academia, public research, and in firms and industries, requires greater policy support and better policy organization. A comprehensive audit of all R&D programmes and activities that includes not only objectives and actions, but also verified and established research capabilities and financial resources, would be a useful first step in this direction. R&D priorities may be redefined following the audit.

Following a Technology Assessment exercise, an STI Policy Road-mapping exercise may be undertaken. The assessment would research the social, environmental, and economic impact of technologies that are available immediately or in the near future and which may be of importance for Zambia.

Finally, a Zambia Innovation Agency should be considered. This national agency would support all forms of innovative projects emerging from start-ups or established firms, from rural communities, from university/business cooperation, etc., throughout the nation, beyond Lusaka and the Copperbelt.

Overview

The Government of Zambia has recently updated its Science, Technology and Innovation (STI) Policy, as promulgated in November 2020. The UNCTAD STI Policy Review outlines the national system of innovation (NSI) in Zambia, including current public support institutions and programmes. It makes recommendations on how to frame the implementation of the 2020 STI Policy to better respond to specific national challenges. This Review examines how STI policy can foster economic recovery while promoting inclusive and environmentally sustainable development, as set out by the Sustainable Development Goals (SDGs). The report consists of ten chapters, which deal with STI issues and challenges and provide policy recommendations.

The first part of this review provides an overview of major challenges faced by the country, of STI efforts and outcomes, and of STI policies and programmes, which are detailed in chapters one through six. This part ends with recommendations that may work towards strengthening Zambia's STI capabilities, essential to energizing and accelerating the national development trajectory. Many of the recommendations concern the fundamentals of STI policy governance, including investments and reorganizations needed in NSI building blocks such as education, research and development (R&D) capacities, and innovation capabilities of firms and industries.

The second part (chapters seven to ten) deals with specific socio-economic challenges. These deserve special attention because they have a certain impact on the ability of Zambia to reorient its development path towards one led by STI. This path would be characterized by increasing productivity and technological sophistication and by more equitable and environmentally sustainable progress.

The seventh chapter is centred on gender issues and STI policy and practice. STI policies can help reduce gender imbalances in various ways: through education and the promotion of STI among women, and through facilitating women's careers in STI fields, in the public and private sectors. More generally, Zambia cannot afford to fail to engage half of its population in its development agenda.

The eighth chapter discusses the digitalization of the Zambian economy and society. Digital technologies pervade all sectors and activities and interact with non-digital technologies in mainstream sectors such as agriculture and manufacturing. It is therefore paramount that efficient policies are in place to ensure Zambia adopts effective digitalization of the country, expanding existing policies and building on existing programmes and institutions.

The ninth chapter addresses the food system. STI policies for the food system encompass the fight against hunger and malnutrition, the need for economic diversification and job creation, sustainable management of land, soils and water, and adaption to climate change. Improving the conditions of food production, consumption and transformation in Zambia requires a systemic STI policy approach that equips the many different actors involved in the food system with appropriate incentives, investments and regulations. A wider consideration is also needed of the environmental and social implications of technology choices.

Chapter ten focuses on the mining sector. It is the main source of the country's economic wealth but provides an unremarkable contribution to lifting Zambia onto an STI-led development path, leaving it well below its potential. The sector itself needs a serious uplift through increasing its capacities for technology absorption to remain globally competitive. Policy actions specifically addressing the sector are proposed after a discussion of trends and issues affecting its performance. These actions concern not only research and technology efforts but also aspects of management and governance.

PART I:
The national innovation system of Zambia

1. Introduction

Benefiting from a peaceful, democratic political context and from an economy largely driven by copper exports, until recently Zambia experienced a relatively smooth growth process, with Gross Domestic Product (GDP) per capita having grown between four to five times in the last 20 years, in addition to noteworthy institutional development.

This comfortable situation has not encouraged it to build up an effective national system of innovation (NSI), with data suggesting a very minor research and development (R&D) effort equivalent to 0.37 per cent of GDP and 50 researchers per million inhabitants.[1] As a result, the sought technology-led development trajectory, defined in Vision 2030, has yet to materialize robustly. Zambia will need strengthened policy action to deploy science, technology and innovation (STI) as catalysts of profound economic and social transformation.

Vision 2030 expresses, at the highest policy level, the development aspirations of Zambians to, "… live in a strong and dynamic middle-income industrial nation that provides opportunities for improving the well-being of all, embodying values of socio-economic justice… " Vision 2030 explains that Zambian development will be based on seven principles: (i) sustainable development and gender equality; (ii) democracy; (iii) respect for human rights; (iv) fostering positive traditional and family values; (v) a positive attitude to work; (vi) peaceful coexistence; and (vii) private-public partnerships.

Vision 2030 is explicit about the role of STI. In paragraph 4.1.30 it asserts that, "… Technology plays a key role in the development of any country since economic progress is realized through innovation and trade. The country thus, needs to intensify the development and application of science and technology in its socio-economic development."

However, to date, policymakers have neither allocated sufficient financial and human resources, nor achieved the required level of visibility for STI policy, to realize the STI mandate of Vision 2030. Thus, the expiring STI Policy of 2009, as well as its predecessor from 1996, has been left almost entirely unimplemented. The current STI Policy, launched in late 2020, will suffer the same fate if there is no change of attitude.

In order to energize STI policies and processes, Zambia will need to strengthen policy implementation and boost its STI capabilities. The recent recasting of STI policies in addition to a dynamic business environment bolstered by investment in ICT infrastructure, services and competent financial institutions, provides scope for optimism.

The key policy challenge will be to strengthen policy coordination and political visibility for STI, with particular emphasis on the innovation effort. Improving policy coordination and political visibility for STI will require substantive institutional input for the Eighth National Development Plan (NDP8), which is under development and will cover the period from 2022 to 2026. It will also require a clear perspective on the socio-economic and sustainable development directions that STI will enable. Policymakers will need to decide what key problems and challenges STI will help address.

A prerequisite for a functional policy will be the introduction of sufficient policy flexibility and the activation of virtuous policy learning cycles, whereby the outcomes of monitoring and evaluation (M&E) are used to fine-tune policy in subsequent periods. Furthermore, to lift the STI policy domain to the highest level, policymakers will need to deeply involve the private sector, and its firms and entrepreneurs, as the core generators of innovation, employment and economic value.

Rebuilding the fundamentals of the STI policy and the innovation ecosystem will require several concerted policy initiatives. These actions should be prepared in collaboration with national STI stakeholders, including the private sector and civil society, while taking advantage of policy support and capacity-building available through development partners and international development agencies. There is an urgent need for key strategic directions to be consistent with NDP8.

Improving coordination and implementation of STI policy will, in practice, require a set of complementary actions. These are as follows:

- In recognition of the problem of insufficient visibility, it is recommended that STI policy should be the ultimate responsibility of a high commissioner directly attached to the office of the President.
- In recognition of the challenge of policy coordination in STI as a cross-cutting policy domain, this review recommends the establishment of a STI policy liaison committee, involving ministries at the level of Permanent Secretaries, for STI programmes and policies of a cross-departmental nature.
- In view of the need for vertical policy coherence, key STI policies, strategies and decisions should be supported in the next and

subsequent National Development Plans in the spirit of Vision 2030.

The achievement of Vision 2030 aspirations will depend on strengthening the education system, financial support for STI activities, and spurring innovation in firms and industries. The effort to harness STI to realize Vision 2030 will require policymakers to address the following three major policy domains:

- **Reform the higher education system**, including universities, as well as technical and vocational schools, to make them increasingly responsive to private sector and civil society demands and to key developmental goals. This will require changes in funding and in monitoring and evaluation mechanisms.
- **Improve and expand support to public research structures,** across the different policy domains and in cooperation between the Ministry of Higher Education (MoHE) and responsible line ministries. A thorough audit and evaluation of research capabilities and technical services is required, in conjunction with a clear assessment of Zambia's STI needs and priorities.
- **Create a National Innovation Agency to scale up current STI activities.** Establishing a powerful instrument to support any innovative projects emerging from start-ups, small- and medium-sized enterprises (SMEs), firms and industries, will be needed, together with an efficient communication system that operates through to the provincial and district levels. This agency, with cross sector responsibilities, should be independent from existing ministries, chaired at the highest level and vice-chaired by a High Commissioner for STI.

This review proposes that the political leadership and STI policymakers of Zambia **launch a national Innovation Action Agenda that could be inspired by three important features of Zambian society:**

- **Inclusive mechanisms for developing a national consensus on the way forward for STI-driven development,** based on the Zambian sense of common and shared destiny, determined in its development through peaceful democratic governance with well-functioning institutions.
- **Commitment to diversified and technology-led industrial development supported by an educated and talented youth,** aware of global technological developments and sustainability concerns, and willing to prove its mettle on the African continent and globally.
- **Strong entrepreneurial capabilities;** Zambian entrepreneurs are self-reliant, outward-looking and enterprising. They are willing to engage in risk-taking, while striving for excellence. They are confidently innovative in their approach to developing commercial opportunities.

This review presents an appraisal of the NSI of Zambia and underscores how the adoption of a systemic perspective is the key to success in STI policy. An NSI is the sum of linkages, relationships, and information and knowledge flows among STI stakeholders. When these are pervasive and of high quality and intensity, they will enable innovators in the private and public sectors, in academia and among the populace, to test their abilities and create wealth and welfare. An examination of the concept of innovation system and its application in UNCTAD's STI policy reviews can be found in UNCTAD (2109).

Using an NSI perspective, together with a focus on the SDGs, allows this review to recommend STI policies and actions that address key STI considerations as well as the challenges of inclusiveness and sustainability. An NSI perspective also facilitates engaging the 2030 Agenda for sustainable development as a vehicle for transformational development.

2. Development challenges and STI

2.1. The economic environment for innovation

STI policies, and innovative firms and industries, are more likely to succeed in growing economies. In Zambia growth shows positive trends, but its demography limits per capita outcomes.

Between 2000 and 2014, Zambia's annual GDP growth rate averaged 6.8 per cent, slowing to 3.1 per cent between 2015 and 2019. However, on a per capita basis, this growth is largely annulled by a population growth of 3 per cent. Prior to the COVID-19 pandemic Zambia had a GDP per capita of about $3,600 in purchasing power parity and $1,300 in current dollar terms, which the impact of the pandemic reduced to $3,278 in PPP terms and $985 in current terms in 2020.[2] In terms of the competitiveness of Zambia's productive sectors, a snapshot of the country's participation in international trade is presented in Box 1.

Box 1: Trade indicators

International merchandise trade

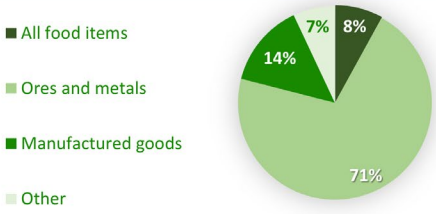
(millions of $/year)	2010	2015	2019
Merchandise exports	7,200	6,607	7,047
Merchandise imports	5,321	7,935	7,225
Merchandise trade balance	1,897	-1,329	-178

International trade in services

(millions of $/year)	2010	2015	2019
Service exports	571	862	1,014
Service imports	888	1,432	1,534
Service trade balance	-317	-571	-520

[e] Estimate

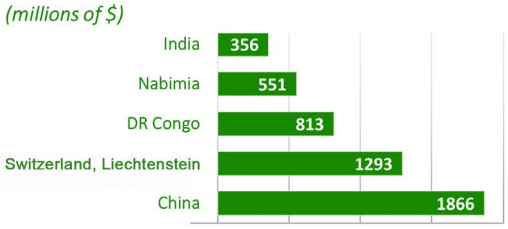
Export structure by product group in 2019



Services exports by main category

(as a % of total services/year)	2010	2015	2017
Transport	7.8	5.1	4.4
Travel	86.1	76.6	80.8
Other services	6.0	18.3	14.8

Top five partners, exports in 2019



Trade indices

Source: https://unctadstat.unctad.org/CountryProfile/GeneralProfile/en-GB/894/index.html

Income inequalities limit demand for STI. Growth has had an insufficient impact on improving broad social welfare. The Gini index of Zambia, estimated by the World Bank at 57.1 in 2015, is among the highest in the region, indicating severe income distribution inequalities. This limits the development of a Zambian middle-class and results in insufficient demand for technology embedded in products and services. Consequently, incentives to invest in STI, by firms and entrepreneurs as well as from the public sector, are modest.

Poverty in rural areas remains widespread. Population growth results in an increase in Zambians living in poverty as economic growth stemming from copper mining does not benefit poor rural areas. Regional disparities have not narrowed, with Lusaka and

Copperbelt absorbing most development gains (World Bank, 2018). During the last 20 years, the Zambian economy has shifted away from labour-intensive sectors to capital-intensive, urban-biased industries that require few new jobs for growth. While salaries have increased during the same period, less than 30 per cent of Zambian households receive any wage income (Bhorat, 2017).

Unemployment is higher compared to other countries in the region. Youth unemployment is high, and entrepreneurship is often out of necessity rather than opportunity and therefore the technology and innovation components are often insignificant. The rate of unemployment has fluctuated between 7.8 per cent and 15.9 per cent during the last two decades.[3] However, youth unemployment has been significantly higher – moving between 16.0 per cent and 28.2 per cent since ,000.[4] Among employed youth, about one third are engaged in unpaid family work and about 40 per cent earn a wage or salary. One quarter are entrepreneurs out of necessity, working for their own ends. Eight per cent are employers. The vast majority – more than 80 per cent – would consider a job in the public sector as ideal, while less than 0.4 per cent actually works in public administration. This poses difficult questions for STI policy, as it is indicative of a risk-averse youth avoiding entrepreneurial activity in favour of safe and secure public sector jobs.

Financial stability gained since the 2005 debt cancellation has been imperilled by rising external and internal debt and a default on external debt interest payment in November 2020. Zambia's public finances are experiencing difficulties. Budget deficits have become a permanent feature and, together with the pressure of substantial domestic and international borrowing, austerity is increasingly presented as an inevitable near-term policy measure. This is a negative for already underfunded and under-resourced STI policy activities. The fiscal shortfall for 2021 is forecast to be above 10 per cent.[5]

Prohibitively expensive cost of capital on the domestic market is a major obstacle for innovative firms and industries.[6] Zambia defaulted on its external debt interest payments in November 2020 and missed a second payment in January 2021. Domestic debt is also a substantial problem as it imposes high interest rates and crowding-out of local entrepreneurs' access to credit. In addition, these circumstances mean investors do not have an incentive to act as venture capital or angel investors.[7] This is a particular problem for innovative, digital and creative entrepreneurs who, as a result, face both a lack of access to capital as well as impracticable interest rates.

Zambia is, however, not an isolated case and the UN has warned that the world faces severe problems of debt sustainability in the wake of the pandemic, causing a variety of threats to developing countries, including hunger, poverty, social unrest and conflict. Argentina, Belize, Ecuador, Lebanon, and Suriname have also defaulted in 2020, while other countries, such as Brazil and South Africa, have worsened their debt positions during the past year.[8]

2.2. STI and the sustainable development goals in Zambia

A divergence in performance between SDGs related to economics and those associated with social and environmental concerns indicates fragmentation in governance and policy and suggests that there are important challenges for implementing cross-cutting policies, such as STI. Attaining the SDGs will require substantial commitment to STI policy and action. Most SDG goals will involve acquiring or developing knowledge, technology and innovation, as well as initiating partnerships with diverse STI stakeholders. They will also require sustainable action through engagement with innovative firms and entrepreneurs. Entrepreneurship-based action and innovation may be inherently more sustainable than programmes or projects financed by one-time or time-limited grants, where activities cease soon after funding is exhausted.

The UNDP Partnership Framework Report that looks at the achievements of the Millennium Development Goals (MDGs), which is a UN development framework spanning ,000 to 2015, notes that Zambia had made significant progress on several MDG targets, but had unfinished work across all of the MDGs (UNDP, 2016). Moving forward to Agenda 2030 and the Sustainable Development Goals, several challenges need urgent attention. Among these are Goal 4 (Quality Education), Goal 5 (Gender Equality), Goal 10 (Reduced Inequalities) and Goal 15 (Life on Land).

SDGs closely tied to aggregate economic performance show positive development, and STI provides important opportunities for sustained improvements. The recently published Sustainable Development Goals Voluntary Review by the Zambian Government[9] looks at the 17 SDG indicators over the period 2015 to 2019. Key findings include progress on almost all indicators of economic and material performance: poverty (SDG 1 and 2), health (SDG 3), water (SDG 6), energy (SDG 7), and industry/infrastructure/innovation (SDG 9).

Several SDGs related to social and environmental issues fair less well, however, and hinder the potential impact of STI. A lack of progress on several social and environmental issues compound existing inequalities in Zambian society. Inequalities do not favour STI-led development, neither in policy design and implementation, nor as drivers of demand for technology and innovation. For example, ICTs are a key element in improving education, accessing information and achieving gender equality. Improving work productivity and wages through technological upgrading reduces the pressure to enlist children as labour. Introducing cleaner, green and renewable energy sources in rural areas can have a positive impact on deforestation, as well as maternal and child health through the reduction of airborne pollution. Unfortunately, the linkages between STI and SDGs are not established in the Seventh National Development Plan (NDP7).

2.3. Major challenges ahead

Economic transformation is slow, indicating the low impact of STI. Changes of sector contributions to GDP and employment do not affect national welfare as agricultural jobs are replaced with equally low-productivity jobs in services.

Industry (including construction, manufacturing, etc., in addition to mining) represents about 35 per cent of GDP and employs 10 per cent of the labour force. Agriculture represents 3 per cent of GDP, though 50 per cent of the labour force are engaged in agricultural activity, most of which is informal subsistence agriculture. The service sector (trade, retail, banking, tourism, etc.) represents 55 per cent of the GDP and employs 40 per cent of the labour force.

The changes in the contribution of industry are largely stagnant and almost entirely related to the prices of copper and the performance of the mining sector and any associated business that services it. While the Zambian economy is fundamentally dependent on copper mining, attempts to use this natural endowment to grow and diversify have largely failed. Even from the perspective of employment creation, where workers have moved away from low-productivity jobs in agriculture, they have found employment in equally low-productivity services, such as retail and tourism, instead of finding jobs in industry. In fact, there has been a significant drop in overall productivity since 2013, estimated by a drop of GDP per employee. The volatility of productivity is indicative of the economic dependency on global copper prices, which it maps. Figures 1, 2 and 3 describe these processes.

This situation is unlikely to change unless Zambia embarks on a broader and more forceful process of technological upgrading. Productivity growth will happen when firms and industries start to absorb both soft and hard technology at an increasing rate and produce higher value products and services. However, high income inequality, and the associated pervasive low wages, is a disincentive for developing and applying technology. The risks of hiring and firing labour – an operating expense – to match the business cycle are much lower than investing in technology – a capital expense – where scaling back in a downturn can be costly due to excess production capacity no longer producing revenues. In addition, the slow pace of the formation of a broader Zambian middle-class results in a suboptimal demand for technology and innovation from Zambian entrepreneurs, firms and industries.

Economic diversification is fundamental to accelerating development in Zambia. However, diversification is heavily dependent on STI, which has low policy visibility in Zambia. Copper mining contributes to 70 per cent of export values, although employing only 2 per cent of the labour force. The impact is surprisingly large given that the contribution of mining is about 10 per cent of GDP, even accounting for growth from an average of 6 per cent contribution to GDP in the late 1990s.[10] Such a strong reliance on non-renewable resources for growth is unsustainable as, eventually, mines become depleted and ore concentrations drop. As previously noted, the mining industry has had little impact on poverty reduction and has created environmental deterioration in and around mining towns and regions.

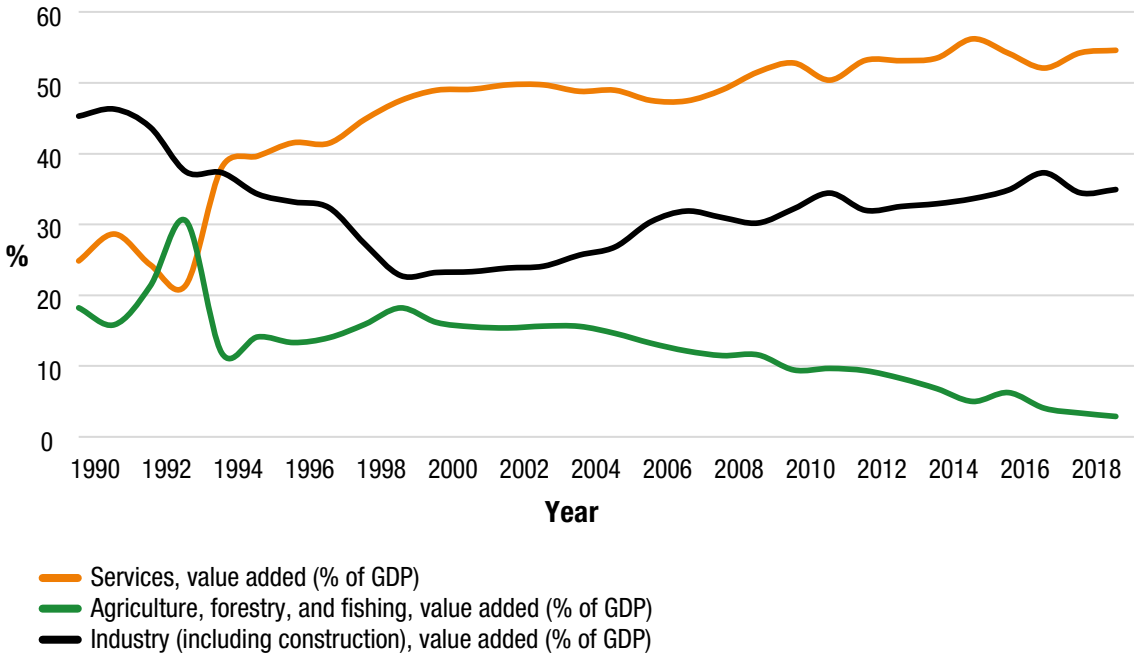
In spite of the size of the mining sector, Zambia's economic performance is locked into the price performance of copper and this is unambiguously evident in figure 4. While institutional development and policy processes targeting economic growth have been identified as positive elements, they have yet to show any impact on loosening the strong dependency on copper exports. Figure 5 shows that there has been no progress in export diversification in more than two decades. This has also been the fate of Southern Africa,[11] albeit at a much higher level of diversification, while most of the group of middle-income developing economies, of which Zambia is included, has steadily diversified.

Demographic growth, climate change and pandemics have severe economic implications as well as strong linkages to STI policy. In particular, diversification and the creation of formal off-farm jobs is a monumental policy task with a strong STI component. Beyond diversification, in the medium- and long-term, Zambia is facing three major

challenges. The first is a massive youth population swell: 50 per cent of the population is less than 21 years of age. Such demographic pressure requires the creation of 400,000 jobs each year for youth entering the labour market. This is a tall order. The official unemployment rate is relatively low at 12 per cent for 2019,[12] and is an indication that a large part of the population is not actively seeking formal employment.

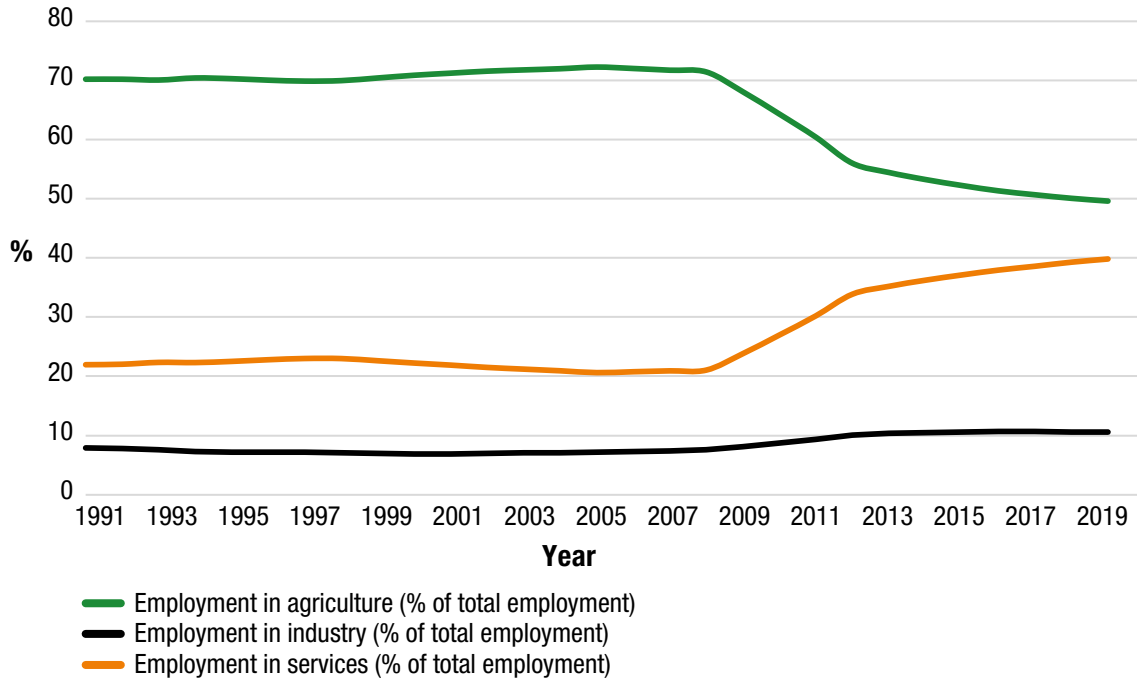
Zambia is keen on job creation, especially for its youth. However, there is a widespread perception among public policy actors that Zambia does not have an adequate industrial base, in terms of numbers of firms and industries, to support such job growth. This may not be entirely true, as this perception seems to focus on large industries and multinationals. It ignores the large number of micro/small- and medium-sized enterprises (MSMEs) which may hold the key to job growth and a less volatile economy if they can access support for technological upgrading and innovation. Enabling firms and industries to expand and diversify into new markets, products and services, through the acquisition and adoption of technology, is critical. Enhancing the Zambian human capital through technological education and training is the other side of the equation for success.

Figure 1: Economic sector by value added to GDP, %



Source: data.worldbank.org

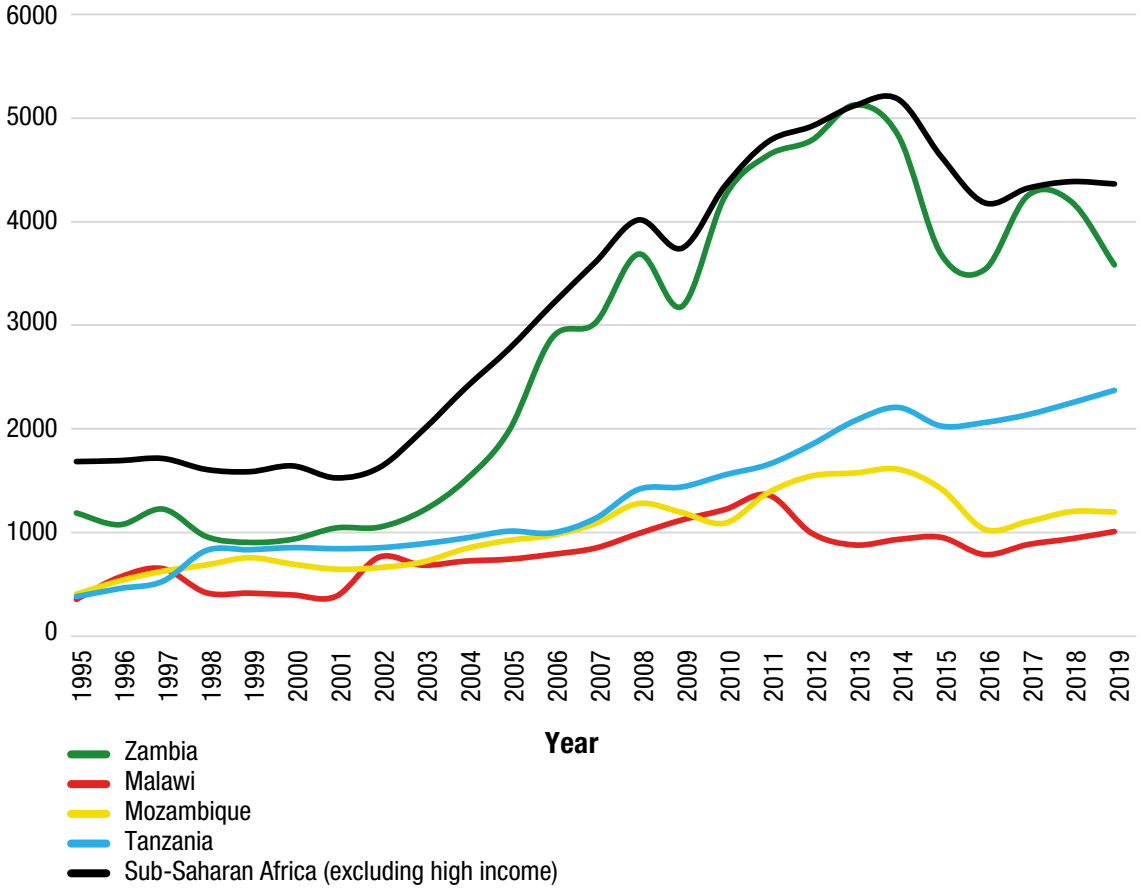
Figure 2: Economic sector by % of total employment



Source: data.worldbank.org

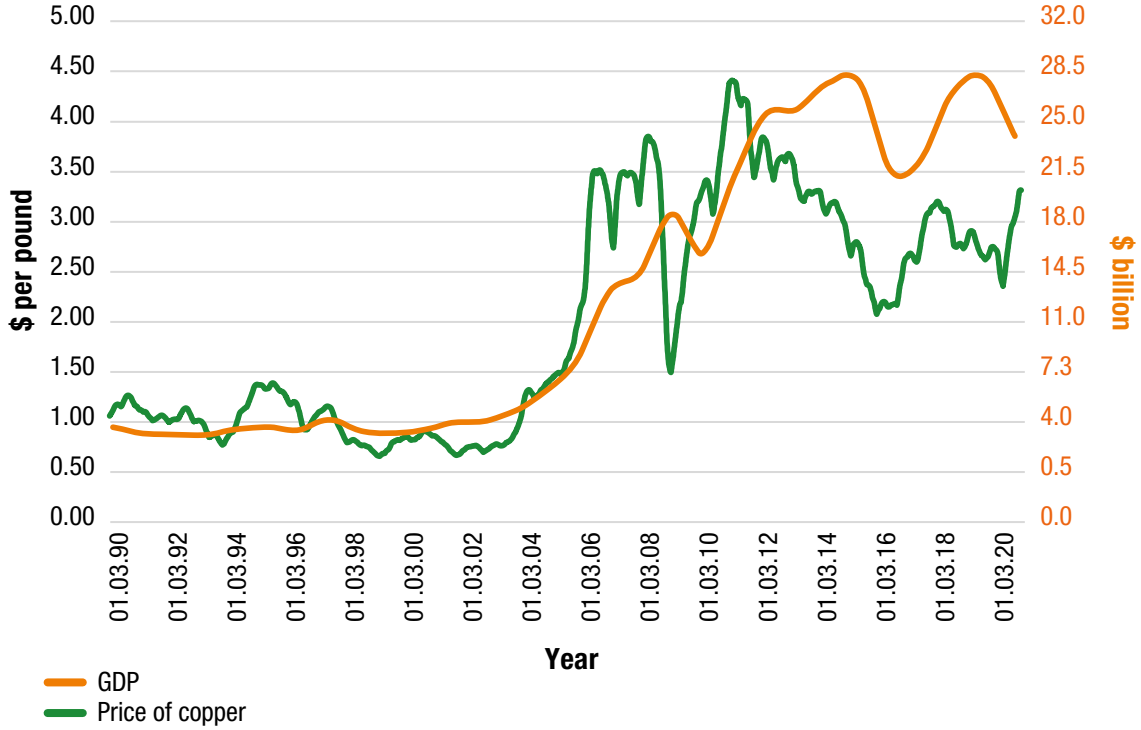
Climate change is another major challenge for Zambia. Most responses have a strong technology and innovation component. The dramatic effects of climate change were seen in 2019 when a drought caused famine, heightened by technologically inadequate food storage and after-harvest processing, as well as the reduction in water levels that consequently affected electricity production. This recent experience confirms that climate change in Zambia causes poverty and increases food insecurity. Climate change contributes to keeping more than half of the country's population under the poverty line, throwing them into a downward spiral of ever greater vulnerability from extreme climate events. As in many other African countries, the use of wood and charcoal as the main energy source in rural areas contributes to deforestation, as well as to respiratory health issues. All these elements are known, and available technological and knowledge-based solutions can help mitigate the most drastic outcomes.

Figure 3: GDP per employee – Zambia and comparators



Source: data.worldbank.org

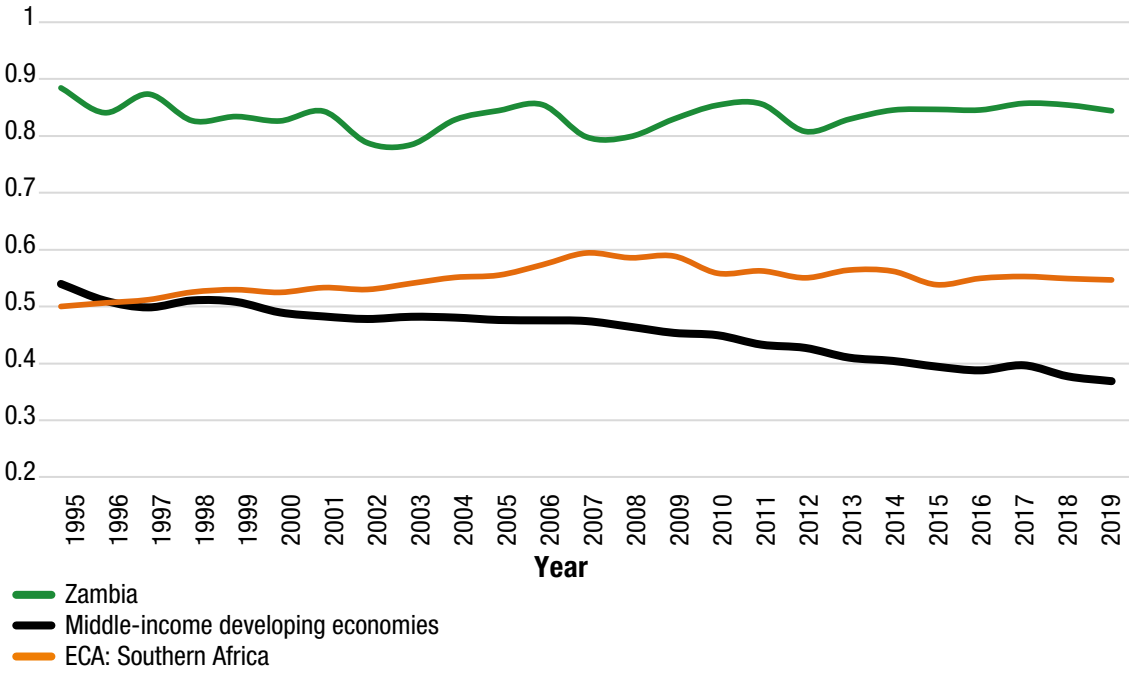
Figure 4: International copper prices 1990-2020 ($, 60-day average) and GDP (current $) in Zambia



Source: https://www.macrotrends.net/1476/copper-prices-historical-chart-data; https://unctadstat.unctad.org/

Pandemic preparedness requires technologically able, agile and innovative firms and industries as well as efficient and effective procurement policies. The third major challenge that Zambia faces, as with most African countries, is how to actively manage and address the COVID-19 pandemic and potential future ones, and their detrimental economic and social consequences. As of 1 March 2021, the impact of COVID-19 in Zambia, in terms of people affected, was some 80,000 cases and about 1,000 cumulative deaths,[13] though these numbers may be underestimated. There are some indications that as many as one in five recently deceased people tested positive for COVID-19.[14] Recovery from the pandemic will challenge the whole innovative capability of Zambian society. Firms and industries that have the flexibility and technological know-how to quickly adapt to new demands in the health sector are central to this endeavour. Public procurement policy and its effective and efficient implementation is the public sector counterpart in these demanding times.

Figure 5: Zambia export diversification (0=fully diversified, 1=no diversification)



Source: https://unctadstat.unctad.org/

2.4. The long view: the need for an STI-based development path

To develop an impactful and strategic view of their development trajectory, Zambian policymakers will need to fully embrace the idea that STI is one of the principal sources of economic diversification and job creation, of productivity improvement and economic growth. A well designed and implemented STI policy is needed that incorporates environmental stewardship while enabling an efficient national response to climate change and contributing to the reduction of inequalities. It is imperative that policymakers dispose of the idea that STI is a sector of its own that mainly deals with scientists in academic research institutions, pursuing intellectual interests of little practical relevance for the country.

Many issues discussed above – except for the pandemic – were already identified when Zambia became independent in 1964. The need to reduce the dependence on copper and diversify the economy, the need to develop agriculture beyond subsistence productions, the need to comprehensively educate the population and the need to reduce inequalities, were all 'on the table' when President Kaunda opened his first mandate.

While progress has clearly been made, the major challenges for Zambia's development identified sixty years ago remain. A new, ambitious and strategic development path is needed. One that is based on STI spurring innovation and diversification, while energizing job growth, reducing inequalities and addressing climate change. The climate challenge has been clearly spelled out in NDP7 following the challenge of diversification identified already by the Government in Vision 2030 15 years ago.[15]

STI and its innovation component will require greater attention. The new 2020 STI Policy that has recently come into force can help in refocusing national development policy on STI, if it gains visibility and if it is implemented.

3. The innovation system of Zambia

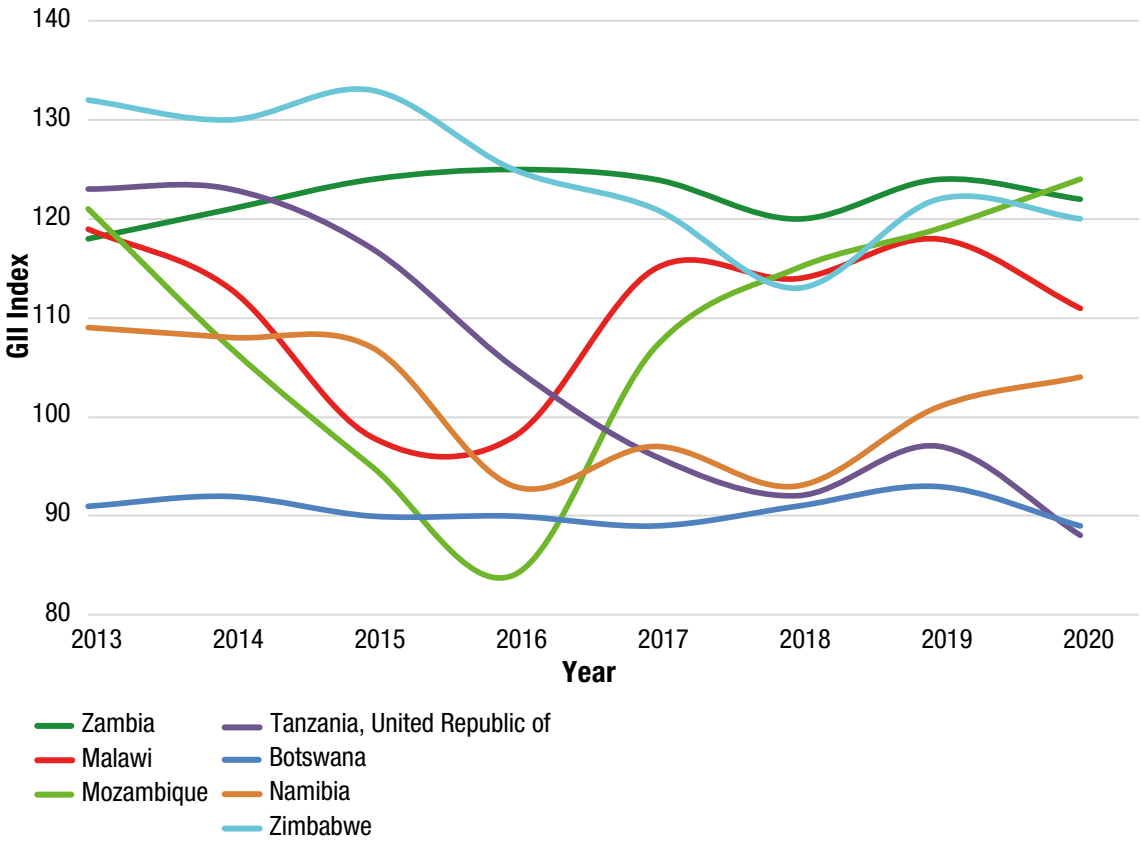
3.1. Indicators and performance

Using the Global Innovation Index (GII) as a benchmark, Zambia's low and declining ranking indicate a need for stronger STI policy action to activate transformative processes.[16] Since the establishment of the GII, Zambia's score and ranking have been declining, despite development gains described by macro indicators such as GDP. Currently ranked 122 in the world, Zambia's performance is lower than those of countries at a similar level of development. This can be seen as describing a stalled diversification process and a decrease in overall national productivity. The GII of Zambia and selected comparators is presented in figures 6 and 7.

GII innovation inputs rank better (109) than outputs (128) for Zambia. This confirms that STI actors struggle to translate science and technology into innovation and should be of key concern for formulating STI strategies and mandates in NDP8. In addition, several indicators qualifying the innovation efforts and outputs that were relatively good in the GII 2019 – such as the R&D effort indicators, and those related to intellectual/industrial property, cultural and creative services – are now mediocre.

On the input side, the performance is relatively good in the *institutions* category. The *political environment* and the *business environment* categories are well regarded, while a good appraisal is made of conditions pertaining to the rule of law, business creation and resolving insolvency. The attention paid to the quality of the business environment is illustrated by the recent establishment of a Business Review Regulatory Agency, which will examine regulations that may affect business activities.

Figure 6: Global Innovation Index ranking, 2013-2019: Zambia and comparators

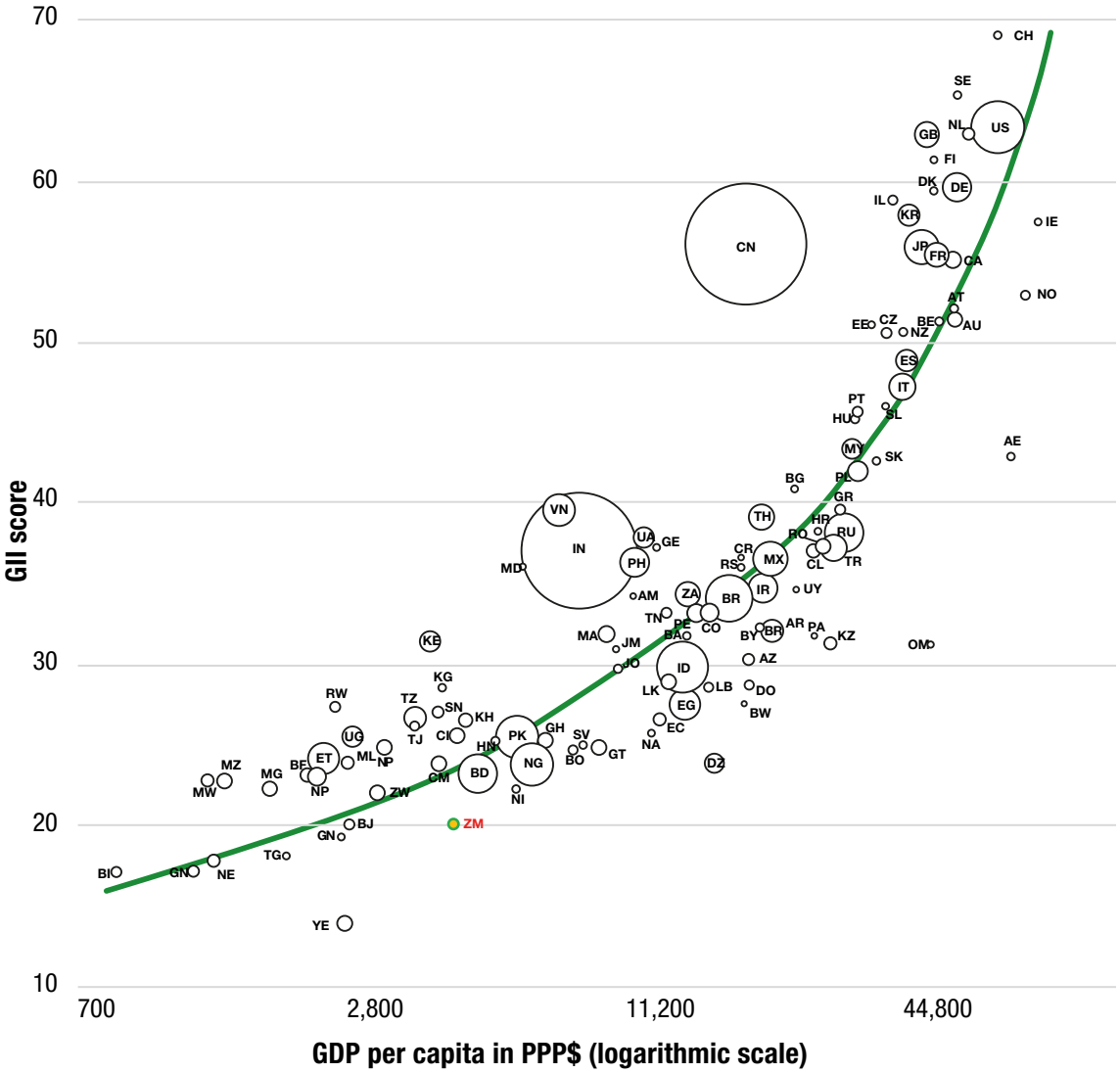


Source: : GII; www.globalinnovationindex.org

The presence of an engaged private sector, active through organizations such as the Private Sector Alliance and its broad membership of business associations, contributes to maintaining a good business climate. The general infrastructure indicator exhibits a good ranking, thanks to strong gross capital

formation. This reflects development policy thrusts in the last decade, characterized by large borrowings from foreign sources coupled with huge construction projects executed by foreign enterprises, some with tied financing through their export-import banks. The reverse side of capital formation indicators is the growing external debt and difficulties in servicing, as discussed in part 2.1.

Figure 7: Global Innovation Index – Zambia and World



Source: Cornell University, the INSEAD Business School and the World Intellectual Property Organization (WIPO) (2019)

The business sophistication and market sophistication indicators present the best ranking set – with knowledge workers, credit, investment, and trade, competition, and market scale components scoring above the GII composite. Surprisingly, there is an ease to obtaining credit – though this does not correspond with perspectives among business community representatives interviewed during UNCTAD's missions in the country. Rankings on the foreign direct investment (FDI) net inflows as a percentage of GDP confirm a good business climate, while this may be overstated as they refer mainly to the mining sector.

The output side is, however, problematic. Neither categories of knowledge and technology outputs, nor creative outputs come close to balancing the input side of the equation. The score contrasts greatly with the favourable score and ranking for the knowledge workers category. Such contrasting indicators lend credibility to the narrative frequently conveyed in interviews during UNCTAD missions: that Zambia struggles to find outlets and applications for its talented and creative youth.

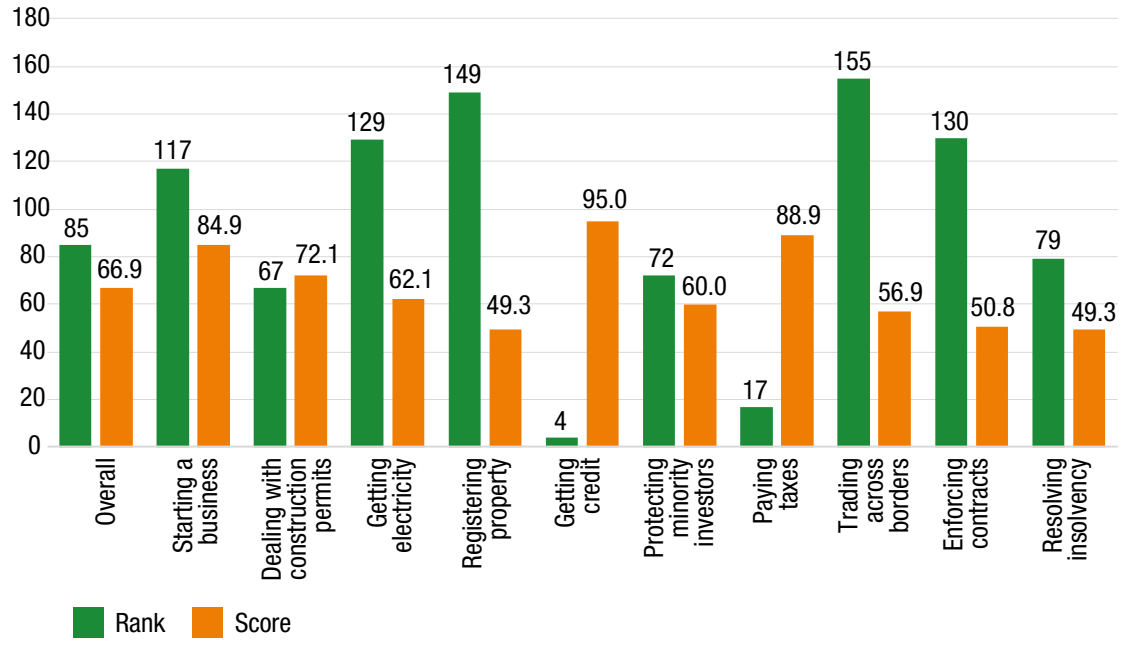
Zambia's GII scores and rankings indicate severe difficulties in operationalizing the NSI. While there

may well be economic challenges and general governance issues that affect all policy domains, the development of institutional capacity for policy implementation in the STI sector should be urgently addressed, including efforts to strengthen policy learning processes. It is encouraging that the 2020 STI policy has been promulgated and that the Government is keen to engage with development partners and international agencies to move forward.

The overall condition of the business environment is a key precondition for STI, given that most innovation happens in firms and industries. Here, Zambia has a positive score on several elements. Complementary indicators from the World Bank Doing Business Report confirm the relative quality of the business climate, primarily regarding financial aspects – ease of obtaining credit, tax management, and protection of investors and so on (see figure 8). Here again, good access to credit shows up as a false positive. Conditions are near unattainable for most firms, especially innovative firms with a technological angle. With interest rates above 35 per cent, given that the return on investment in ventures where a product or service is produced in Zambia hardly approaches 35 per cent plus any risk premiums, credit may perhaps serve to finance short-term trade, such as in the import business, and not much else.

Entrepreneurial dynamism among Zambians varies. Many businesses, including new innovative start-ups, as well as in more mainstream sectors, are often created by migrants of non-Zambian origin, from Western or neighbouring countries, or by Zambians returning after time spent abroad studying and working. Their experience is indicative of how an appropriate business climate can stimulate the establishment and growth of SMEs in Zambia, including in rural areas (Sardanis, 2014). By contrast, it appears that local Zambian entrepreneurs not only prefer safe investments in areas that do not require much or any technology development or upgrading, such as farming, but prefer to diversify early on into several ventures instead of nurturing one activity. This behaviour is an expected and natural risk management strategy. Measures introduced by the Government that should further improve the business environment include, dual citizenship to attract entrepreneurial migrants, a Citizen Empowerment Commission to help people create their own business, and a one-stop-shop service for firms and entrepreneurs by the Ministry of Commerce.[17]

Figure 8: Doing business in Zambia - Rankings on business topics



Source: https://www.doingbusiness.org/content/dam/doingBusiness/country/z/zambia/ZMB.pdf

Zambia's parastatals have negligible innovative drive. However, privatization shows that private ownership and private interest in the outcomes of business ventures is not a sufficient driver for innovation. Parastatal enterprises used to constitute massive actors in the Zambian economy, controlling up to 80 per cent of GDP in 1980. But they were not innovative by nature, as they benefited from rent situations (PMRC, 2015). Their privatization, however, has not stimulated innovation efforts to

any great extent. As illustrated by the mining sector, uneven technological upgrading and insufficient investment in technology and innovation has been common among foreign investors who invest in Zambian enterprises. Today, competitive pressures combined with a host of new technologies (notably digital ones) and government agencies involved in support of entrepreneurial endeavours, such as the IDC, could help improve the innovative performance of the Zambian economy.

3.2. Linkages between actors in the innovation system

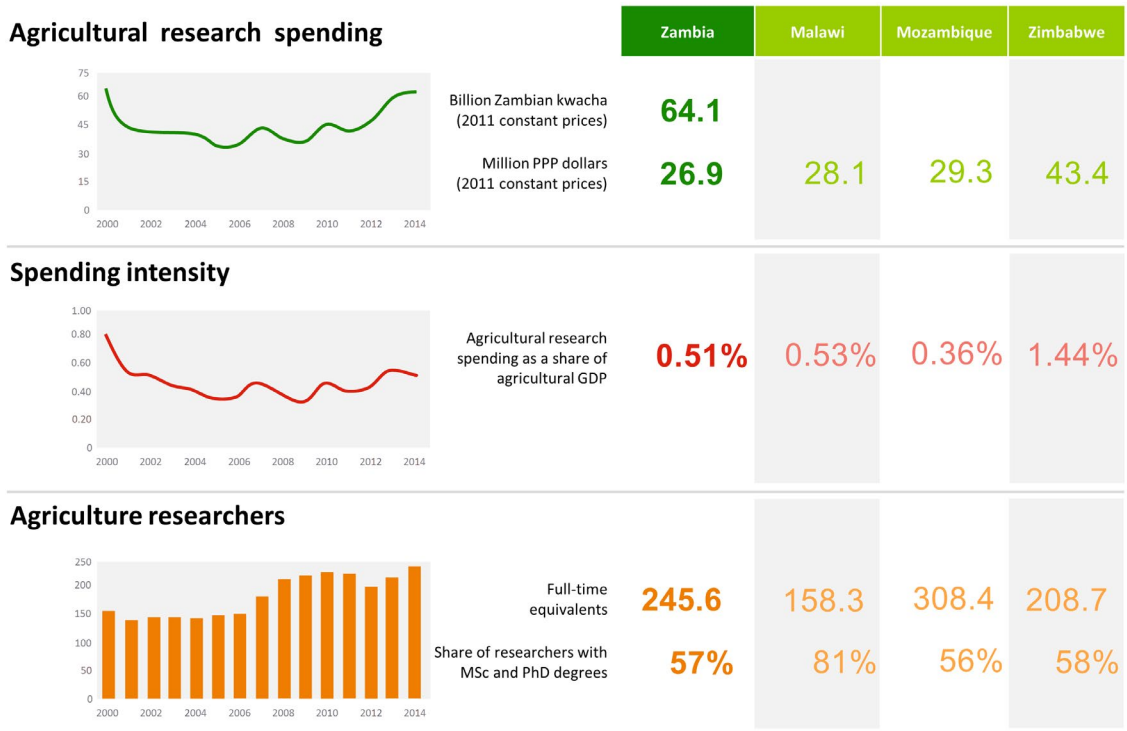
Linkages between research institutions and other actors in the NSI are nominal or weak. A key element of the NSI is the quality and quantity of linkages between STI stakeholders. These may also be seen as interactions between innovators (firms and industries), knowledge and technology producers (firms, research organizations and academia), educational structures, financiers, regulators, policymakers, and markets and beneficiaries (consumers, civil society, and environmental interests), to name a few. Although Zambia is ranked 95 on the GII in innovation linkages, upon closer discussions with STI stakeholders during UNCTAD's missions in Zambia, it became apparent that interactions were not commonplace. When they did materialize they were an expression of goodwill and civility, while expectations of practical outcomes decreased as stakeholders' distance from policymakers initiating such activities increased.

Public research institutions are active, particularly when supported through international programmes and development partners. This is the case of the National Science and Technology Council (which manages significant programmes in health and agriculture) and the Remote Sensing Centre (which monitors earth and territory in relation to climate change). While the quality of research is commendable and certainly deserving of recognition and support from the international community, the use of research outputs at the innovation end of the STI equation seems limited, as there are few identifiable partners among firms and industries.

Research in agriculture remains underused due to modest extension services system which is the main link in the lab-to-field process of technology transfer. There is some research done in agriculture and fisheries, mainly by the Zambian Agricultural Research Institute (ZARI). Donor funded research peaked in the mid-2010s and has since decreased as projects have wound down – a clear example of the unsustainability of non-entrepreneurial approaches to STI. Figures from 2014 indicate that Zambia invests about 0.5 per cent of its agricultural GDP in agricultural research, which is half of the minimum recommended by the African Union. ZARI is dependent on donors and development partners for two thirds of its non-salary budget. Figure 9 describes trends in R&D in agriculture until 2014.[18]

Extension services are the main mechanisms linking research and technological knowledge with farms. Extension services are provided by government-supported private-sector entities and development partners, while the Ministry of Agriculture and Ministry of Fisheries and Livestock focus on their core functions of policy formulation, enforcement of legislation and regulation. The Ministry of Agriculture also operates the National Agricultural Information Services with its main role of supporting the extension services of the ministry through the dissemination of agricultural technical information to rural communities.

Figure 9: R&D in Agriculture in Zambia and comparators (2014)[19]



Source: ASTA Network, https://www.asti.cgiar.org/

In 2011, in the public sector, extension support employed 742 staff members and 308 senior management staff. Seven of the senior staff members had a PhD and 31 were trained at the Master of Science level. Women account for 13 per cent of senior management staff. There were 64 subject matter specialists, 323 field-level extension staff and 26 ICT staff.[20] The most active players in private sector extension provision are seed companies.

Among the key 13 challenges for extension recognized in the National Agricultural Extension & Advisory Services Strategy several can be highlighted:

- A focus on technology outside the context of markets and values chains.
- A low extension worker to farmer ratio of 1:1200.
- Inadequate refresher training of extension staff.
- Constrained access to agricultural information and technologies due to gender inequality.[21]

In the upcoming period, the Government intends to strengthen extension services through the Farmer Input Support Programme (FISP). FISP beneficiaries will be supported to adopt climate smart agriculture technologies and practices and will be migrated to a cost-effective e-voucher system.[22]

Stronger linkages between academia and industry need to tap the national knowledge base and prepare Zambia's youth to respond to the needs of a more diversified and innovative economy. This requires collaboration among diverse government entities to draw in academia and industry and exploit common ground and synergies. Currently, there is no evidence of systemic R&D collaboration between academic institutions and industry. Interactions between the two are not supported with incentives or in any planned manner. None of Zambia's universities have technology transfer or intellectual property offices. The University of Zambia has a manifest need of greater resources for research. Its laboratory equipment is outdated or non-existent. This leads to excessively theoretical teaching and students graduating without any hands-on experience.

Programmes assisting the development of training opportunities for students, in Zambia or abroad, require development. Internship programmes are modest and reliant on the goodwill of firms and industries, rather than on a structured approach. Contact responsibilities and programme development for internships are the mandate of MoHE. However, the Ministry's familiarity and access to firms and industries, given its mandate, is limited compared to the Ministry of Commerce, Trade and Industry, or the Chamber of Commerce. Stronger collaborations

among these and other organizations are needed to overcome widespread silo operational modes. This situation may not match the interests of the academic community, and motivation to engage may be lacking. Interest in joint R&D, training and internship initiatives could be encouraged by funding to improve industry academia interaction and by improving communication. Greater transparency is needed around collaborative activities currently taking place as positive examples will serve to energize the NSI.

3.3. Education

The education level of the population is fundamental for any country's development capability and is a basic pre-condition for embarking on STI-led development. Zambia has made serious efforts to improve education at all levels, as witnessed by measurable improvements in the ,000s. The Ministry of Education significantly enhanced access to basic education, after years of underinvestment, by implementing development plans and abolishing school fees in 2002 (IOB, 2008).

Today, more than 84 per cent of children attend primary school with a completion rate of above 70 per cent for both sexes.[23] These rates drop rapidly in lower secondary and upper secondary to about 50 per cent and 27 per cent respectively.[24] There are important concerns about the quality of education, including for the attained level of learning. NDP7 explains that, "…(o)ne of the major challenges … is the low quality of education as evidenced by low performance results in the National Assessment Surveys." Solutions proposed include revising curriculums at primary levels and improving the supply of learning and teaching materials (including ICT) and upgrading teacher competence. Poor conditions often promote rote learning targeting assessment tests. While this may be necessary to achieve basic literacy targets, greater attention should be paid to strengthening creative and critical thinking among all school levels, including primary. While there is gender parity at primary levels, at tertiary levels males outnumber females 3:2.

The Zambian technical and vocational education and training (TVET) system will require scaling up to provide a qualified and productive workforce for increasingly technological development in services and industry. Better linkages between industry and the TVET system are necessary. Enrolment was about 47,000 in 2015, compared to more than 800,000 pupils in secondary education, so it is no surprise that a critical training and technical competency gap has opened. Representatives of firms and industries have shared similar impressions in discussions during UNCTAD missions. Only 0.5 per cent of total government education expenditure goes to TVET, while the proportion is much higher in other countries in the region (almost 10 per cent in Rwanda and 7.5 per cent in Liberia, for example). More problematic still are the large numbers of TVET diploma holders who cannot find a job, because their skills are ill-suited to the labour market.

The TVET system is funded through a 0.8 per cent tax on business pay roll. Discussions with representatives of private sector firms and industries revealed a certain lack of satisfaction with the competence and abilities of trainees coming from TVET schools. A major issue was that, due to the poor or non-existent training equipment in the schools, hands-on knowledge and experience was modest among graduates.

Possible solutions lie in closer cooperation between private sector and TVET schools, with importers and distributors of equipment, machinery and other technology. Importers may access incentives, to be legislated as proposed under STI or technology transfer mandates, to import servicing and demonstration equipment, some of which may be used for training in collaborating TVET schools. TVET is administered by the Technical Education, Vocational Entrepreneurship Training Authority (TEVETA) government agency operating under the Ministry of Higher Education. There are 283 TVET establishments. Around 100 are under provincial and local government management, while 30 are managed by the Ministry of Higher Education.

Zambia has long-standing and reputable universities. To increase their contribution as an STI stakeholder and NSI actor, universities will need to improve the work-readiness of their graduates and engage more profoundly with firms and industries on both training and research agendas.

At the higher education level, there are six public universities and 18 private universities. Founded in 2015, the Government-established Higher Education Authority (HEA) is the regulator for higher education and acts as a registrar for public universities. Universities are free to develop curricula and programmes but must seek accreditation from the HEA. MoHE funds public universities who supplement their budget with modest tuition fees (Mkandawire, 2019). Tuition fees for private universities are in the range of $2,000 to $4,000 per student/year, while public universities are around $1,000.

Table 1: Universities in Zambia: student enrolment by type of institution and gender

Name	Type of institution	Male	Female	Total	STEM	note	Graduated (2016)
University of Zambia	Public	13,406	11,270	24,676	✔		3,926
Copperbelt University	Public	8,010	3,650	11,660	✔		1,669
Kwame Nkrumah	Public	4,710	4,173	8,883	✔		
Mulungushi University	Public	2,644	2,107	4,751	✔		858
Chalimbana University	Public	1,442	3,279	4,721	✔	only math	
Mukuba University	Public	1,023	1,320	2,343	✔		
Total	**Public**	**31,235**	**25,799**	**57,034**			
Percent	**Public**	**55%**	**45%**				
Lusaka Apex Medical University	Private	2,834	4,299	7,133	✔		290
University of Lusaka	Private	3,454	3,295	6,749	✔	only medicine	713
DMI St. Eugene University – Chibombo	Private	2,402	1,955	4,357	✔		165
Rusangu University	Private	2,052	2,027	4,079	✘		
Zambian Open University	Private	1,595	1,925	3,520	✔	only agriculture	971
Cavendish University Zambia	Private	1,579	1,270	2,849	✔		
Chreso University	Private	636	970	1,606	✘		
LIUTEB	Private	766	707	1,473	✘		
Northrise University	Private	434	291	725	✔	only ICT	
Zambia Catholic University	Private	288	419	707	✔	only ICT	
City University of S&T	Private	371	159	530	✔		
DMI St. Eugene University – Chipata	Private	250	180	430	✔		
Africa Research University	Private	183	98	281	✘		
DMI St. Eugene University – Woodlands	Private	102	109	211	✔		
Trans-Africa University	Private	132	60	192	✘		
Evangelical University	Private	28	28	56	✘		
Southern Valley University	Private	17	9	26	✔		
African Christian University	Private	7	4	11	✘		
Total	**Private**	**17,130**	**17,805**	**34,935**			
Percent	**Private**	**49%**	**51%**				
Total public and private		48,365	43,604	91,969			
Percent		53%	47%				

Source: MoHE Annual Higher Education Census, 2016/2017

Table 1 gives basic figures on Zambian universities. The gender balance favours men in the public universities, while the opposite is true for private universities. To speculate, this might be because there are more STEM programmes offered in the public universities, and there is a male bias towards STEM enrolment. There would be merit in deeper research into the causes of such an imbalance.

Most universities offer several STEM programmes at undergraduate level. However, data on enrolment per course will need to be analysed to guide policy decisions. To the extent that the interest expressed by foreign students for specific universities is an indicator of their quality, the top five universities for international students include the University of Zambia, the Copperbelt University, the Information and Communication University, the University of Lusaka and Mulungushi University.[25] The University of Zambia has been ranked in the top 20 best African universities.[26] Its operation as a STI stakeholder in the national innovation system, however, and more generally its contribution to the country's development process, is difficult to ascertain. The overall number of enrolled and graduating students is modest. As with TVET diploma holders, it is not easy for university graduates to find a job, especially if they graduate from public universities. Those graduating from business-oriented private institutions may enter the economy more easily.

Discussions with representatives of firms and industries revealed that some had internship programmes for university graduates and used these to preselect future employees. Their main challenge related to the lack of professional skills and aptitudes from graduates with largely theoretical knowledge. To remedy this situation, on-the-job training and sandbox environments had to be created for up to a year, even for IT or computer science graduates. These are an extra and demanding cost, especially for small and innovative Zambian businesses that already accept significant early growth-phase risks. The solution is to increase the level of interaction between firms, industries and academia, but it is doubtful that this will happen on its own without the mediation of MoHE and its agencies, as primary catalysts in energizing the NSI.

3.4. Energy

Universal access to energy for citizens and a robust supply for firms and industries is a key condition for technological innovation. Zambia is making steady progress on this front while challenges remain due to its reliance on hydroelectric generation and the consequences of drought brought on by climate change. The STI development potential of Zambia is closely tied to its energy resources. Digital technologies are entirely dependent on a reliable electricity supply, while other industries rely fully on imported fuels for transport and logistics, as well as local power generation.

Biomass is the main source of energy for 70-80 per cent of Zambian citizens and consists of charcoal, firewood, and forestry and agricultural waste (FAO, 2020).[27] Cooking is the key energy activity that uses biomass as a fuel. As a result of the intense use of biomass, Zambia suffers high rates of deforestation. Biomass fuel also contributes to the moderately unsafe levels of air pollution. In Zambia, the annual mean concentration of PM2.5 is 27 µg/m3 and exceeds a maximum of 10 µg/m3 recommended by the WHO.[28] It follows that the STI challenge for biomass is how to make its production and use cleaner and more sustainable.

In 2019, 13.9 per cent of the rural population had access to electricity. There are multiple consequences of such a low level of access, including challenges in providing health, education and ICT services. The impact on entrepreneurship is critical as modern ICTs are a key enabler of any innovative and profitable venture. The Ministry of Energy (MoE) has set a goal for universal electricity access for all Zambians by 2030, while energy has been identified as an important driving force behind economic development in Zambia in its National Energy Policy of 2019.

Zambia is supporting the development of solar through the IFC-world Bank Scaling Solar programme and the Zambian REFiT Strategy, an initiative developed with the support of German development bank KFW which plans to install several plants of 20 MW capacity each.[29] The Zambian Government is aiming to deploy 500 MW of solar generation capacity by 2023, in order to further reduce chronic power shortages that will likely become more severe as a result of droughts and climate change.[30] Zambia has very low greenhouse gas emissions, managing only 0.3 tons of CO2 annually per capita, compared to the world average of 4.9 tons. Therefore, Zambia's incentive in moving towards solar power generation is in improving energy security and overall national capacity.

Since 1995, electricity production and Zambia's energy regulation is open to private investment. Since then, independent power producers have been operating with results that are below expectations. Low electricity tariffs – Zambia has the lowest tariffs in the region – and the high cost of financing, are major disincentives.

The Government of Zambia aims to enable and encourage private sector participation to improve infrastructure development in the energy sector. In effect however, most of the electricity supply is operated by the vertically integrated state-owned utility. Some pockets of private sector activity occurs across generation, transmission and distribution market segments. Several power companies are jointly owned as a public-private venture.

Main policy directions are expressed in the National Energy Policy (2019) which competently defines actions and linkages, including with STI stakeholders such as MoHE (in roles that to some extent should correspond in the future to the new Ministry of Technology and Science) and academia. However, its action plan is extensive and may benefit from a revision that would develop greater prioritization among its 148 policy actions. The policy specifically highlights eight policy activities for collaboration and implementation with several ministries, including the Ministry of Higher Education. Policy measure 4.2.9 refers specifically to Innovation, Research and Development and proposes as its objective, "… [t]o promote innovation, research and development in the energy sector in order to accelerate technological advances."

4. STI policies and initiatives

4.1. Policy framework

A new STI Policy was established in late 2020.[31] For the it to be relevant it is critical to develop an effective operational framework to introduce STI policy considerations into NDP8 and, by consequence, ensure successful implementation. The key challenge for the new STI Policy will be its implementation. Overall, the science and technology institutions exist and their mandates are clear. However, expert staff is limited in numbers, and financial resources will need to be enlarged. Coordination with agencies and line ministries requires reconsideration to improve the directionality and coherence of implementation. Coordination and collaboration will need to further extend to all STI stakeholders and beyond government organizations, to firms and industries.

STI-related efforts and initiatives in Zambia are not negligible and can even be significant in specific areas. There are multiple projects and activities with common ground, but these lack coordination and therefore miss out on potential synergies. A major concern is that there is no way to articulate STI activities and initiatives in the process of drafting the five-year National Development Plans (NDPs). This is despite the formal procedures that are established to define NDP actions, and which translate into budgetary support to the Ministry in charge of STI and other government bodies with important STI activities. Coordination among STI stakeholders on how to influence NDP design outcomes requires careful attention to process and format. The responsibilities in this area will fall under the purview of the new Ministry of Technology and Science that was established in September 2021, where the Department of Science, Technology and Innovation that was mostly responsible for the STI activities under MoHE, is reinstated.[32]

The institutions mandated with implementation of STI policy will need to profoundly rethink and reorganize activities through a dramatic increase in collaboration, as well as through stronger partnering with international organizations and development partners. The current system of ministerial clusters has yet to show results. If nothing changes, the budgets needed for supporting the STI development of the country will remain minor. Also of concern is the current financial situation of external debt default and budget restraints. These border on austerity and will make implementation of the 2020 STI policy an overwhelming challenge.

The ICT policy domain, by contrast, offers a more positive perspective, largely stemming from growing demand in the telecommunications sector and the overall advance of digital technologies that have become pervasive in all sectors of society. Policies and initiatives in three other policy domains, namely, gender, mining and food, as well as ICT, will be considered in separate chapters in this review.

4.2. STI institutions and organization

STI Policy in Zambia has a long institutional history, and polices and institutional setups have transformed in response to the changing economic environments. Zambian policymakers have had a certain appreciation of the STI policy domain since independence. In 1967 the Zambian government established the National Council for Scientific Research (NCSR) with consultations from UNESCO. The NCSR fell under the Office of National Development and Planning. The NCSR was mandated to coordinate STI activities and designate research priorities as inputs for the NDP process. The Act also mandated the establishment of a Venture Capital Fund.

Zambia's STI policy framework was revised in 1996 when a national STI Policy was established. It was followed-up with the Science and Technology Act of 1997 which, as its primary purpose, established the National Science and Technology Council (NSTC), and its Science and Technology Development Fund (STDF), mandated to regulate, fund, promote and coordinate the research. The functions of the NSTC are presented in box 2. The Act also established the National Technology Business Council (NTBC) and its mandate to commercialize technologies for the benefit of entrepreneurs and business communities as well as to manage a venture capital fund, yet to be established.

Box 2: Science and Technology Act of 1997: Establishing the NSTC and its key functions:

a) Promote the development of an indigenous and environmentally friendly technological capacity;
b) Regulate research in science and technology in Zambia;
c) Register institutes and centres;
d) Advise the Government on science and technology policies and activities in Zambia;
e) Determine broad directions, stimulate co-ordination and initiate special projects in science and technology;
f) Promote and publicize broad national priorities in science and technology research;
g) Liaise with government, industry and centres and institutes in science and technology;
h) Mobilize and distribute financial, human and other resources for science and technology research;
i) Recommend to the Government the establishment of any new research institutes and centres;
j) Promote the use of science and technology in industry;
k) Ensure that gender concerns are integrated at all levels of science and technology development;
l) Collect and disseminate science and technology information, including publication of scientific reports and journals;
m) Establish and maintain a relationship with corresponding scientific organizations in other countries;
n) Take all measures that are necessary to popularize science and technology;
o) Identify and determine national research and development priorities in science and technology; and
p) Do all such activities connected with or incidental to the functions of the NSTC under this act.

Source: http://nstc.org.zm/wp-content/uploads/2020/08/Science-and-Technology-Act.pdf

In 1999, the National Remote Sensing Centre (NRSC) was established under the provisions of the 1997 Science and Technology Act to deal with remote sensing and geographic information systems technologies. It is controlled by a board instituted under the same Act, while the overall policy supervision belongs to MoHE. In 2001 the NCSR was replaced by the National Institute for Scientific and Industrial Research (NISIR) which inherited all the research mandates of the NCSR. All three institutions have been since functioning under MoHE. Complementing the described institution-building and legislation, the Biosafety Act of 2007 established the National Biosafety Authority, while the National Health Research Act of 2013 established the National Health Research Authority. The Intellectual Property Rights Policy of 2009 and the Patents Act of 2016 are other pieces of legislation completing the STI regulatory framework.

The elaboration of the 2020 STI Policy took a decade of discussions and consultations. The reasons for such a slow process included difficulties in developing a consensus among many actors operating in different policy fields, which is inherent in the cross-sector nature of the STI policy domain. A sense of urgency about STI was lacking, given more immediate and easily relatable economic concerns, such unemployment, inflation or exchange rates, as well as the prices of basic food commodities, which are fundamental to social cohesion. The convening power of MoHE and the NCSR reached only so far, and collaborating stakeholders bestowed upon the process their token participation, while remaining discreet in terms of critical reflection and substantive contributions.

In preparation for the revised Policy, a draft National Science, Technology and Innovation Policy Paper had been developed and discussed with numerous stakeholders. The foundations and arguments for the STI Policy are well developed in the document. Economic and social challenges are highlighted. The innovation and competitive capabilities of the different sectors of the economy are well summarized. Challenges of the STI system are identified. These include the need for human and financial resources; the need to reach a critical mass of STI activities and interactions to precipitate an economic effect that is measurable at the macro level; the need for a greater focus on priority issues; and the operational habit of functioning in silos, which is uniformly present among institutions across all policy domains. The 2020 STI Policy has a broad set of objectives (see box 3). It also promotes the aim to spend 1 per cent of GDP on R&D in 2030, an allocation to come mostly out of the national budget.

Box 3: Objectives of the 2020 National STI Policy

- To strengthen the policy, legal, institutional and operational framework of the STI system
- To strengthen and build the human resource capacity in STI
- To strengthen the commercialization, transfer and diffusion of technologies
- To exploit the Indigenous Knowledge System for national development
- To improve investment and funding in STI
- To ensure quality assurance in STI
- To promote and popularize of STI

The new 2020 STI Policy will generate impact only to the extent that the Ministry and collaborating institutions are empowered and supported with capacities and resources to implement it. The overall coordination remains, according to the Policy, in the hands of, "The Ministry responsible for Science, Technology and Innovation (which) will be responsible for policy coordination, implementation, and monitoring and evaluation." As noted above, until September 2021 this was the responsibility of the Ministry of Higher Education, which had a department dedicated to STI policy, but only a small number of staff and experts. The Department is now placed in the new Ministry of Technology and Science, with no indications of change in the resources available to it. Therefore, it will require significant strengthening and capacity-building if any implementation of the Policy is to be expected. Given the objective limitations in human and financial resources, worsened by the strains of the debt default and the COVID-19 pandemic, a greater involvement of international development partners should be sought to support capacity-building and implementation.

The institutional system, in which the 2020 STI Policy needs to function, has not changed compared to previous policy cycles and is characterized by relatively modest and scattered resources and dispersion of policy efforts and responsibilities. The hierarchical structure remains the same and is clearly defined in section 5.1 of the Policy. The top authority is the [Presidential] Cabinet [of Ministers] which provides overall policy direction on STI. MoHE, the coordinator (now presumably replaced in this role by the Ministry of Technology and Science), and other line ministries are the second level. However, it is not clear how policy direction is developed, whether there is a defined process of interaction with other stakeholders who may provide specialist insight, and how this direction feeds into the process of preparation of the NDPs.

A further third level in the policy hierarchy is made up by the Government agencies that carry out specialized technical functions, such as the NSTC, NTBC or NISIR. Below these is a fourth level described in the Policy as domain of, "… the actual implementation

of activities and this level will constitute the research institutions, universities and R&D support centres." While this seems well structured and clearly defined at first glance, pushing implementation down to the said institutions will provoke two key challenges. The first is the challenge of monitoring and evaluation of implementation activities which will be, by analogy, moved down to this fourth level. The second is that, as defined, this fourth level has a very limited scope of stakeholders, principally involved in R&D. It is only a small part of STI activities in terms of both volume and impact and therefore any monitoring and evaluation will carry conclusions of similar significance.

A new institution is planned – the Zambia Academy of Sciences (ZaAS) – to be established as an autonomous association of scientists whose main aim shall be to provide independent and objective advice on STI. One may question the relevance of such a new body. To a certain extent, the existing NSTC (discussed below) already plays an advisory role. An academy of scientists could be in a better position to provide neutral advice, if it is detached from any operational activity. However, this is not the purpose of ZaAS. Consideration needs to be given also to the notion that science academies tend to draw the whole STI policy narrative towards scientific research activities, often to the detriment of the technology and innovation dimensions. This is a certain policy risk, as Zambia will need to refocus on the innovation side if science and technology are to have any impact on national economic performance and welfare.

Several critical issues may need to be addressed beyond the 2020 Policy. These are, among others, the actual coordination mechanisms between the coordinating ministry and other line ministries, as well as private sector and civil society stakeholders. Silo-breaking measures are urgently required to improve coherence in both policymaking and policy implementation. The key question is how STI policies, multi-year programmes and projects flow into the process of developing the next and all future NDPs. A well-defined process to feed STI policy directions into NDP development will render STI work more effective and enable the identification of appropriate resources for STI activities. It will also ultimately lead to improved monitoring and evaluation and opportunities for policy learning whereby evaluations feed back into adjustment for future policy work.

4.3. Research structures and programmes

The need for more coordination is particularly important for an STI Policy with very limited resources for research. Several agencies are active. However, their impact is marginal given the modest resources at their disposal. MoHE had the responsibility to oversee research activities developed in higher education establishments as well as in public research centres. Sector-related research activities are developed by the line ministries in charge of agriculture, livestock and fisheries, environmental matters, health and so on. In most programmes, international cooperation plays an important role, not only in providing funds but also in orienting research activities. However, to better use limited resources, strategies and priorities will need to be defined in a more systematized way. Two organizations involved in discussion with the UNCTAD mission can serve to illustrate the nature of science and research efforts, but each has its limits.

The NSTC oversees and promotes the science and research activity of Zambia. It monitors the scientific population through a register and manages related international cooperation. It is tasked with stimulating public interest for science through events and exhibitions. The NSTC supports research activities with two funds: a Strategic Research Fund (ZMW10 million or about $0.45 million), which supports five to six projects per year, and a recently created Science and Technology Innovation Youth Fund, which awards ZMW250,000 per project, primarily focused on wealth and job creation and implemented by youth up to 35 years of age. Development partners are actively engaged in the NSTC, with one dollar invested by Zambia in NSTC internationally supported programmes generating nine dollars from foreign sources. The NSTC recently published a strategic plan for 2019-2021 which spelled out clear institutional objectives after a review process with evaluation indicators on past achievements.[33]

The NTBC promotes, markets and transfers technologies to enhance the utilization and adoption of new technologies and innovations to contribute to industrialization, economic development and job creation. The NTBC has two core functions. The first is the commercialization of innovative products, and the second is the transfer of technologies. It does both through the following support pillars:

- Technology acquisition and transfer;
- Business development support;
- Technology marketing and promotion;
- Technology audit and validation;
- Provision of technology information; and
- Promotion of intellectual property.

The fundamental idea is to support innovative ventures and demonstrate their commercial viability. Having done so, the NTBC can eventually generate investment into these ventures from private sector investors. Questions remain however, as to the amount of return investors expect, given local bond yields of 35 per cent.

The National Institute for Scientific and Industrial Research (NISIR) is a government agency reporting to MoHE. On establishment, it inherited the mandate and functions of the NCSR. The main mandate of NISIR is to conduct and promote scientific, technological and industrial research in diverse fields.[34] In practice, the NISIR has an operational water programme, but it lacks funding and, beyond this, mandates have been generally inactive. While the NISIR is funded by the Government through monthly subventions, funding for programme activities beyond bare operating costs have proved to be challenging. Multilateral and bilateral development partners are encouraged to fund specific projects, while the Institute can generate some income through contracted research. With a new board and CEO appointed in April 2021, the NISIR will be able to revisit and prioritize its mandate, as well as to seek synergies and more structured cooperation with national and international partners.

The NRSC, designed as an inter-institutional body (with several ministries in the board as well as representatives from business and farmers' communities), collects satellite data to monitor earth and soil development. It plays an important role in monitoring floods, deforestation and desertification, etc. It works with a budget of $150,000 with ten researchers and ten support staff. Most of its resources come from involvement in the multi-country WeatherNet project[35] of the Southern African Science Service Centre for Climate Change and Adaptive Land Management (SASSCAL).[36] The Centre's current programme of activities, running from 2018 to 2022, has a budget of $23 million and includes 88 projects, 14 of which involve Zambia. The key challenge for the NRSC is that the funded research does not include provisions for disseminating outcomes of WeatherNet to concerned users in local communities and rural areas. While WeatherNet posts data on its open-access website, the ability to access the data (through broadband subscriptions and hardware) is lacking in many rural areas.

4.4. Innovation support and technology services

While funding for STI activities in Zambia is modest, there are few takers willing to engage when financial support is available. This may lead to the reduction of available resources in the future. Application requirements for funding need to better match the realities or interests and aspirations of firms and entrepreneurs. The Technology Business Development Fund (TBDF) is a funding vehicle reporting to MoHE. It provides support to firms with innovative projects. The TBDF offers seed money and subsidies that are reimbursable if a project is successful. The project selection and management processes are in line with the international experience, but the available financial resources are extremely limited and amount to between $200,000 and $300,000 per year. In 2019, 19 proposals were received, of which four were selected for support. According to TBDF management, three times as many projects could be valuably supported. This lack of so-called 'deal flows' is not uncommon in developing countries. It is usually the result of application requirements that are not well matched to realities or interests and aspirations of firms and entrepreneurs. This is a highly problematic situation. While funding for STI activities in Zambia is modest, there are few takers when financial support is available. This may lead to the reduction of available resources in the future.

The National Biosafety Authority, which is another MoHE agency, is largely inactive. Established in 2007, but with a CEO nominated only in 2016, it is supposed to act in various sectors (pharmaceuticals, health, agriculture, etc.) and most notably in the trials and regulations of Genetically Modified Organisms (GMOs). Dependent on multiple ministries and actors from different sectors and communities to develop activities and impact, it has never elicited much interest in the Zambian context, even though it is equipped with some R&D facilities and testing instruments.

The Ministry of Commerce, Trade and Industry (MCTI) does not formally carry the mandate for STI

policy. Nevertheless, it is active in the STI domain and has several agencies that support technology and innovation. The 2018 National Industrial Policy of Zambia stipulates as activities in its legal framework, among others: "… [the] (iv) Review of legislation on Technical Education, Vocational and Entrepreneurship Training, Science and Technology, Information, Communication and Technology, Forestry management and environmental management so that the sectors effectively support Governments industrialisation agenda." It has eight agencies and statutory bodies of which several are described below.

Intellectual property activity shows a bias towards trademark registrations and relatively few fillings for industrial design and patents. This is indicative of a non-innovative economy. The Patents and Companies Registration Agency (PACRA) provides intellectual property services to businesses. PACRA has a staff of 20 and is mostly focused on trademarks (see table 2). From a legal and regulatory point of view, in regard to intellectual property (IP), Zambia is compliant with international standards as a signatory of key World Intellectual Property Organization (WIPO) treatise and conventions.[37] There are expectations that the registration of utility models may be introduced in 2021. There are also reports of an increase of patent applications from international pharmaceutical companies, as well as Chinese firms, especially those involved in renewable energy.[38] The most recent changes in legislation on IP relate to the adoption of the Industrial Designs Act (2016, Act No. 22 of 2016), the Layout-Designs of Integrated Circuits Act (2016, Act No. 6 of 2016), the Patents Act (2016, Act No. 40 of 2016) and the Protection of Traditional Knowledge, Genetic Resources and Expressions of Folklore Act (2016, Act No. 16 of 2016).[39]

Table 2: Intellectual property in Zambia[40]

	Trademarks			Industrial Designs			Patents			Copyright			Total			Total Active	
Year	Lodged	Granted	Renewed	Lodged	Granted	Renewed	Lodged	Granted	Renewed	Lodged	Granted	Renewed	Lodged	Granted	Renewed	"Granted and renewed"	In force
2015	1 650	1 051	950	21	12	7	39	17	217				1 710	1 080	1 174	**2 254**	**6 848**
2016	1 687	1 606	578	69	14	5	33	27	120				1 789	1 647	703	**2 350**	**7 259**
2017	2 134	1 291	1 598	28	73	4	22	18	105	141	96	45	2 325	1 478	1 752	**3 230**	**7 705**
2018	2 024	1 528	1 028	39	20	8	24	12	95	187	158	29	2 274	1 718	1 160	**2 878**	**7 717**
2019	1 952	1 875	1 043	58	47	7	23	9	116	141	122	19	2 174	2 053	1 185	**3 238**	**7 726**
Yearly average	1 889	1 470	1 039	43	33	6	28	17	131	156	125	31	2 054	1 595	1 195	**2 790**	**7 451**

Source: PACRA (2019); WIPO

A Patent Policy is in the works, although it has been pending for cabinet approval since 2015 and so has no assumed date of adoption. Like the STI Policy case, this is an indication of the need to strengthen interest in and awareness of STI as a crucial development question throughout Zambian society and up to the highest level of policymaking. The bias towards trademark registrations and relatively few filings for industrial design and patents is indicative of a non-innovative economy. It also indicates a need for stronger underlying industrial and STI policies, including a stronger collaboration between these policy domains.

The importance of standards and metrology is recognized in Zambia, with two fully operational and active agencies. These are the result of a heightened awareness among Zambian private sector firms and industries and policy institutions about the need and role of standards and reputable standards agencies.

The Zambia Bureau of Standards (ZaBS) oversees norms and standards as well as of quality certification and assurance. The resources are significant with 150 staff and a budget of $2.5 million.[41] The Bureau charges for its services. The revenues that are

generated reach approximately $1 million. In 2019, 440 standards have been published and 91 product certifications have been awarded. ZaBS is active in facilitating trade in the regional integration framework (Southern Africa Development Cooperation).[42]

The Zambia Weights and Measures Agency oversees both legal metrology and scientific and industrial metrology. Also, in 2019, 3,000 services of calibration of instruments, and 33,000 verifications were delivered. Non-tax revenues rose to $2 million, and this represented an increase of 32 per cent compared to 2018. The agency also received a $2 million grant from the Government.[43]

4.5. Innovation and large-scale projects

Zambia is ready to engage major investments in actions of direct interest towards an STI-based development of the country through the operation of several well-funded initiatives.

In addition to the STI Policy and supporting laws, institutions and support services for STI, it is important to mention several initiatives that are ready to engage major investments in actions of direct interest towards an STI-based development of the country. Four initiatives deserve to be highlighted. They are particular in that they all mobilize international financial support.

The global initiative Green Climate Fund (GCF) – funded at $10 billion, globally available – is active in Zambia through multiple-country programmes and through Zambia specific programmes. Two Zambia-specific projects spanning 20 years have been approved. One is for building a renewable energy financing network and is a $154 million project with 38 per cent funding from a GCF loan. The other is aimed at supporting agriculture livelihoods to cope with drought and climate change. Among its aims are the development of climate resilient inputs and practices and sustainable water management. It is a $137 million project, funded at 23 per cent by GCF.

The Industrial Development Corporation (IDC) controls and oversees state-owned corporations and is the major agency of the Government supporting industrial development and modernization. It has 33 companies in its portfolio, and it invests in all sectors of the economy, including tourism, manufacturing, energy, ICT and education. In total, companies controlled by the IDC employ about 100,000 workers, and their assets are estimated to reach $7 billion. The IDC's operations involve making minority investments and acting as a catalyst. Its activities can have major transformative effects, such as the building of agro-industrial plants and developing value chains and logistics networks. For example, the Mwinilunga Kalene Hills Fruit Co. Ltd. canning factory will engage, when open, 2,000 farmers growing 14,000 metric tons of pineapple, and create 200 jobs at the plant. It has recently opened two solar power plants with the combined power of 88MW peak and has invested in other infrastructure, such as the Indeni Petroleum Refinery and the Mpulungu Harbour.[44]

The biggest advantage the IDC has over all the other ministries and agencies is its highest-level governance. The IDC Board of Directors consists of HE President Lungu, as Board Chairman, and the three Ministers of Finance, Agriculture and Commerce, Trade and Industry, as well as the IDC CEO. The IDC Board of Directors provides overall guidance and policy directions to the Management of the Corporation. The Board meets periodically to decide on matters pertaining to overall long-term strategic objectives, major investment and divestment proposals, as well as major funding proposals. Similar highest-level governance models have been used in many countries to implement strong STI-led development and should be considered as a model for a possible Zambia Innovation Agency.

The National Pension Scheme Authority has been in operation for 20 years, initially succeeding the National Provident Fund. It has under management assets worth $29 billion, of which $2 billion are invested. It is currently developing a scheme to provide investment capital to firms that promise bankable high-growth start-ups and to SMEs with an equally high growth potential. The amount of investment planned in the scheme would reach $100 million over five years. As with the TBDF, a key concern is deal flow. With yields on domestic bonds at 35 per cent, attaining similar returns from investment in equity may prove challenging.

A major nuclear project is being developed directly under the auspices of the President. An implementation blueprint has been approved by the Zambia Cabinet in November 2020.[45] The country has suffered frequent electricity shortages in recent years. The long-term plan (2035 and beyond) is to build a large nuclear power station that will fulfil a significant part of the country's electricity needs. This operation is planned to begin in 2025 with the building of a large research centre. The centre would gather, in one place, research and training in diverse scientific disciplines and technologies (including metallurgy, nuclear science, radiology, etc.) and related applications (in health, environment, etc.). The intended investment in this research centre would represent about ten times the budget currently spent annually on R&D in the country and would employ

10,000 scientists and engineers – 10 times the number employed today. If confirmed, these plans would create a serious imbalance in the STI system, in that 90 per cent of national STI activities would revolve around nuclear research. Technological and financial support for this project has been agreed with Russia as the key provider.

4.6. Diversification opportunities and STI

STI-led development and diversification policy and programmes have broad common ground. Often, common sense pushes the consideration of diversification proximate to the main economic activities of the nation which, in Zambia's case, is mining and agriculture.

Innovative opportunities, beyond mining and agriculture, are difficult to define as a matter of policy without observing trends, assessing proximate value-chains, or gauging expectations among entrepreneurs. In Zambia, in the cases of agriculture and mining, there are few productive activities beyond the immediate or primary-level treatment of natural resources. To remedy the situation, efforts made in the agriculture sector and incubators for agri-business will require greater commitment and investment. Diversification programmes will need to engage larger numbers of innovative farmer-entrepreneurs to reach a critical mass that can have measurable impact on the economy. These and other agriculture challenges are discussed in greater detail in chapter 9.

Diversifying on the back of the mining sector remains a huge challenge, as the sales and export of copper are often claimed in advance by investors or their partners in the global value chain and in international markets. Building industry that uses copper as an input will require the redefinition of commercial relationships, but incentives are not clear and goodwill for development outcomes may not be a commercially viable priority for incumbent operators. The mining sector will be discussed in greater detail in chapter 10.

If the political economy of agriculture or mining is slow to reorient towards improved diversification outcomes, other sectors must be considered, such as tourism, FinTech and energy. Policymakers see the tourism sector as a potential source of jobs and wealth. Tourism can benefit from, and validate, infrastructure investments (hotels, roads, airports, etc.) and favourable tax conditions. Education and training for hospitality and management are key. In addition, the development of a broad eco-system of collaborating sectors, such as health, agro-industry, nature preservation, and creative industries, are needed to enrich Zambia's tourism offer and support economic diversification.

Linkages with local communities and civil society are important for developing what the country can offer to tourists, as well as for ensuring a more equitable distribution of tourism revenues. Technologies deployed may be advanced (ICTs, Internet of Things, etc.) and environmentally sound, such as complementing energy use with renewable sources, and green technologies for water and waste management.

Among emerging sectors, a particularly dynamic cluster is forming around FinTech, which is flourishing in many African countries in the wake of the Kenyan MPesa. Many applications are proposed to facilitate various types of banking, virtual portfolios and other services. There are also innovative mechanisms put in place to encourage household savings, including by the poor. One example is a scheme to facilitate saving practices among people in the informal sector who keep money hidden in personal places.[46] In early 2020, the pilot operation had reached 20,000 people. To make it profitable for the bank 100,000 are needed. There is a competitive business climate in Zambian FinTech: 13 mobile wallet providers were registered in January 2020. FinTech has policy support, and support from development partners, even though it is a soundly commercial sector, because it has a positive impact on financial inclusion. Several examples are presented in box 4. The payment services business is estimated to reach more than $1 billion in the next five years.

Another dynamic cluster has developed around solar energy, its capture and use in rural and urban areas, coupled with innovative modes of digital payments by individuals or organizations making use of solar energy. For example, Fenix International designs, manufactures and distributes ReadyPay Solar kits, a mobile payment-enabled off-grid solar panel and smart battery system. According to Fenix, an estimated 15 million or 80 per cent of Zambians live off the electrical grid. Fenix International started operating in Zambia in October of 2017. It also operates in Uganda, where it hosts its main service centre, as well as Côte d'Ivoire, Benin, Nigeria and Mozambique. With support from development partners – the Swedish Embassy and USAID – Fenix has reached 150,000 Zambians in partnership with telecom MTN. They provide the financial infrastructure in the form of a pay-to-own home solar system financed through affordable instalments via mobile money. Challenges include the distribution to remote areas while relying on a fragmented transport logistics sector, largely based on a 'one truck – one owner' model.

Box 4: Fintech in Zambia

Lupiya.com is a Zambian-based microfinance start-up founded in 2015. Lupiya is an online marketplace for microloans – a branch-less and fully digital operation. It uses digital technologies to make the process of borrowing simpler and easier so that people and businesses, including those in rural and remote areas, can access financial services. Recently Lupiya received an investment of $1 million from Enygma Ventures, a US venture capital fund. Loans are tailored for personal use, business use, or specifically for women. 70 per cent of Zambians do not have access to credit due to lack of collateral required to secure a loan. Lupiya's goal is to provide this 70 per cent with access to financial services by 2022. While access is a notable goal, due to exceedingly high domestic interest rates on government borrowing of around 35 per cent (see section 2.2), it is difficult to find capital willing to accept lower returns. The unfortunate result is that loans are available, but at annual interest rates approaching 60 per cent.

Source: https://ventureburn.com/2020/07/zambian-fintech-startup-receives-1-million-investment/; https://www.lupiya.com/

The FinTech4U Accelerator Programme is a three-month accelerator programme designed for entrepreneurs who have recently started a FinTech business. The United Nations Capital Development Fund (UNCDF) and BongoHive technology and innovation hub partnered on developing FinTech4U. In mid-2020, the programme accepted ten applications from Zambian early phase start-up FinTechs that offer innovative services to all Zambians, especially those that are traditionally underserved. UNCDF and BongoHive explain that there are three important reasons why accelerator programmes are critical for Zambian start-ups. The first is that Zambian start-ups require support for iterative product testing with actual potential customers. The second is that start-ups have challenges in accessing and linking up with other partners in FinTech and ICT. Finally, start-ups often lack experience in navigating regulatory requirements. The second FinTech4U accelerator cohort was closed with three winning FinTechs. Each improved its business model to better meet the needs of underserved Zambians and will be awarded a $5,000 grant.

Source: https://fintech4u.co.zm/

Zazuafrica.com describes itself as a, "… money app that helps you store, use and learn about money." Founded in October 2015, Zazu initially helped farmers sell extra produce in new markets. In 2017, it started developing its FinTech operations, first by launching a chatbot which sends texts to inform consumers on financial services. It then built a digital wallet connected to a prepaid card. Zazu raised $1.4 million in funding in 2019. Its new Mastercard-issued virtual card was launched in 2020 with support from Tutuka – a Dubai-headquartered global payments enabler – and is connected to the wallet. FinTech and mobile money has been a strongly developing sector in Zambia, reaching about half of the population by 2020 and with more than four million active users. Zazu and other FinTech and mobile money platforms have, as well, a significant cost advantage over traditional banking. Zazu aggregates diverse financial service providers in a Zazu app to help discover the best offers for insurances, loans and other financial services. Though fully commercial, Zazu has maintained its linkages to rural Zambia through its collaboration with the Conservation Farming Unit (CFU). The CFU works with smallholder farmers, assisting them to adopt climate smart agriculture. With a stipend, these farmers are supported in their innovative efforts and eventual adoption of climate smart agriculture. These stipends can only be spent on specific items in vetted shops. The CFU uses Zazu to ensure this. In the background, Zazu routes payments between all parties, and provides the CFU with an audit trail, to prove their impact to their funders.

Source: https://www.fintechfutures.com/2020/07/zambian-mobile-wallet-zazu-launches-virtual-card/ https://www.zazuafrica.com/about-us

Another firm, SolarWorX, develops modular solar home and business systems and distributes them through local partners. SolarWorX is also involved in pico and mini grid projects. SolarWorX operates on an entrepreneurial model with the aim of reaching true economic and ecological sustainability. Recent activities in Zambia included the installation in late 2020 of almost 200 solar energy systems and direct current (DC) appliances in Mumbwa, 160km west of Lusaka. Customers used PayGo, an instalment payment model via mobile money, to finance their purchase. As in the case of Fenix International, off-grid power, mobile money and connectivity have become inextricably linked. More recently, development partners The Energy and Environment Partnership Trust Fund (EEP) Africa committed to supporting a SolarWorx pilot in Zambia for decentralized smart grids based on interconnecting solar home systems (SHS).[47] The project aims to distribute up to 300 SHS connection points to rural households, which will upgrade SHS owners to small-scale independent power producers. The project aims to recruit 50 per cent women sales agents.

5. Challenges of governance

5.1. Political context

Since its independence in 1964, Zambia's democratic foundations have helped the country forge its way through important socio-economic challenges, and will continue to do so in its quest for accelerated STI-led development. Institutions play their role for ensuring smooth and fair election processes. Religious organizations and non-governmental organizations (NGOs) have contributed, in their part, to maintaining a peaceful social and political life. The peaceful character of Zambian society is expressed through the relatively low level of violence, as compared to other countries at a similar development level.[48]

Though this feature of Zambian society is easy to understate, it must be considered fundamental to the design and implementation of Zambia's STI policy for two reasons. Firstly, Zambia sees itself as having a distinct political heritage and journey which, despite challenges and difficulties, has always remained peaceful, unlike experiences in neighbouring countries. This unique self-awareness and sense of destiny is a characteristic of nations who have managed to move forward with impactful STI policy. Secondly, peaceful societal outcomes indicate an acceptance of collaboration and compromise as necessary processes in the development of national policy. Given that STI policy is underfunded and under-resourced, and that it is a cross-cutting policy domain, the only path to success is one of cooperation among concerned government institutions, as well as private sector and civil society STI stakeholders.

5.2. Governance and public management

Zambian policymakers and STI stakeholders need to create a sense of urgency around the STI agenda. Institutions and governance mechanisms are in place and can support such actions, if the right decisions are made. Originally inspired by a humanist and socialist ideology at the outset of its independence, Zambia has put in place a well-structured development planning process. A five-year National Development Plan is elaborated through a formalized process involving more than 5,000 policymakers and experts from diverse agencies and institutions.

There are top-down mechanisms starting from the Ministries, down to the district level, by which frameworks and guidelines are provided to local bodies. Conversely, a bottom-up mechanism transmits information on local needs into the planning process.[49] These flows are coordinated by the Ministry of National Development Planning. Zambia is in the final year of NDP7, and NDP8 is under preparation and will probably span 2022 to 2026. Unfortunately, the debt crisis has delayed the planning process for NDP8, as well as the implementation of NDP7. All NDP discussions have been delayed, as the focus has been on the negotiation of a national recovery plan and on fiscal measures that will generate sufficient tax revenue to start paying back creditors.

NDP7 was organized around five pillars (clusters) according to the ministries concerned: economic diversification and job creation, poverty and vulnerability reduction, reducing developmental inequalities, enhancing human development, and creating a conducive governance for diversified and inclusive growth. NDP7 highlights agriculture, mining, tourism, and industrialization as key drivers of growth, and energy and infrastructure as key enablers. NDP7 was 86 per cent compliant with the Sustainable Development Goals (MNDP, 2020). However, this process has largely failed the STI policy domain and agenda. NDP7 sees STI as a subcomponent of education and skills development. It also treats R&D as unlinked to STI and as a development outcome of diversification and job creation. While NDP7 takes

note of the 1996 STI policy, its treatment of STI is relatively weak and this should be a heads-up for all STI stakeholders involved in designing NDP8. In contrast to Zambia's challenging economic predicament, there seems to be little sense of urgency for STI policy, or fundamental attention to its importance and role.

At a level of concrete action, several Zambian economic and financial institutions are well respected for their operations. This is notably the case of the IDC, the Bank of Zambia, and the National Pension Scheme Authority. All of them have taken useful initiatives to support innovation. On the other hand, the level of corruption is an important challenge and has been officially recognized, including in the recent SDG Voluntary Development Review regarding SDG16 - peace, justice and strong institutions. Even so, most governance indicators related to the level of regulations and government efficiency are above regional levels.

STI policy perspectives will need to move from a still dominant linear science-push paradigm, to an NSI and STI-demand perspective to develop and implement effective STI policy. Countries that have succeeded in energizing STI-led development have abandoned the preference for a linear sequence that starts with science, moves onto technology and ends in innovation. In its place is an NSI perspective, where STI stakeholders are networked in an innovation ecosystem with innovative firms and institutions at its core, and this is used to design and implement STI policy. Innovation has not been the prime focus of STI strategy in NDP7, nor in the 1996 STI Policy, and therefore innovation outcomes have been weak. It follows that the STI-demand side of STI policy will need to be developed.

Improving the visibility for STI is imperative. STI stakeholders will need to accept and understand their role in the NSI. Outside key policy experts and stakeholders, the visibility of the work and mandates on the STI of MoHE, and agencies which report to MoHE, is poor. STI will strongly benefit from improved communication to their target audiences, and even within the Government. The 2020 STI policy recognizes the need for a "… popularization of science, technology and innovation". However, the matter is more complex than simply addressing the broader public and building awareness of STI. The key concern is the awareness of the STI mandate and its activities among other ministries, public agencies, academia, firms and industries, and civil society organizations (CSOs), as well as among the nation's legislators. Embracing their role in the cross-cutting STI mandate is an important policy element. Moving further, actively breaking down institutional silos and engaging in collaboration among legislators and policymakers, and with MoHE as a coordinator and catalyst for the STI agenda, will be a foundational element of a stronger NSI for Zambia.

STI-led development addressing Zambia's key SDGs and development aspirations would benefit from a more equal society. The presence of severe inequalities in Zambia – be they across income, gender or expressed as the urban-rural divide – is in contradiction with the country's Vision 2030 aspirations. Inequalities can be a target of a well formulated STI policy as well as a major impediment to its implementation. Policymakers must categorically reject the notion that inequalities in Zambia are an acceptable consequence of its historic development path or development policies that support free market and entrepreneurial economics.

6. Policy recommendations

In view of the importance of STI to address major challenges faced by Zambia, and considering its current institutional STI landscape which could be better supported, several specific, determined and firmly conducted policy actions are needed. Of course, such STI policy actions will not be effective if other policy actions are not taken in crucial areas, such as education and finance, as well as action needed in the policy areas of gender, digital technology, mining and food, all of which are discussed in part II of this review.

Taking into account of the manifest capabilities demonstrated in different parts of the Government and economy, none of the actions proposed below are particularly complex for Zambia to implement. It is more a matter of political will and increasing the awareness of the significance of STI-led development. It is also important that all these actions are conducted in collaboration with development partners and international organizations, especially as a significant portion of the financial resources needed may come necessarily from foreign and international partners. A high level of conviction must be demonstrated, and the rationale of the role of STI in the development process must be well understood and regarded as central to the policy landscape.

Recommendations pursue two main objectives: first, raising the status of the STI policy in the Government and establishing strong coordinating mechanisms, and secondly, restructuring the STI policy institutions and capabilities by well-targeted reforms and support programmes.

6.1. Raising the status of STI policy in government

Several strategic decisions and actions should be considered to energize the NSI of Zambia.

a) **Better articulate the role that STI can play for the medium- and long-term development of the country.** This should take place within a renovated vision for the country along the 2030-2040 horizon, with a clear understanding of demographic, urbanization, climate and other long-term factors, and the role that knowledge, technology and innovation can play in solving key problems faced by the country.

b) **Establish an authority for STI (perhaps a High Commissioner, for lack of better term) attached to the President and with constitutional rank that would empower coordinating authority over cabinet ministers.** Within the current functions of Zambian institutions, any ministry responsible for STI has insufficient reach in terms of activating cooperation with other line ministries. This top-level authority would oversee and guide the entire spectrum of STI efforts and initiatives and play a coordinating role in ensuring a coherent and long-term STI strategy. It is important that this authority is established with a mandate that defines a certain level of independence so that it can function with continuity beyond any potential impediments created by political cycles.

c) **Establish a liaison committee on STI matters at the level of Permanent Secretaries of all concerned ministries for overall coordination or related to specific projects that would be time-bound.** These are needed to break out administrative silos that tend to proliferate in government structures and are particularly deterrent to STI activities, which are transversal by nature.

d) **Ensure a more effective integration of STI mandates and actions within the national planning process for NDP8.** An inter-ministerial group needs to be established to develop a strategy and mechanism to support this action. The group needs to be headed by the Permanent Secretaries, while policymakers working on implementation should be involved, well informed, and their viewpoints properly considered.

e) **Strengthen the managerial and expert capacities and budgetary resources of the Ministry responsible for STI to enable it to supervise and fund STI structures and activities.** While it may be difficult to increase funding in the near-term, capacity-building through cooperation with international organizations and development partners is an entirely workable and realistic option.

MoHE may alternatively refocus its responsibilities to the guidance of higher education and TVET, reaffirm its relationship with the HEA of Zambia and focus only on science, while reducing its role in technology and innovation mandates.

This would require the establishment of a Zambia Innovation Agency, which would bring under its wing all existing practical implementation of technology and innovation mandates, activities and agencies and which would develop as an institution along the lines of the IDC. The Agency might, for example, have the President of Zambia as its Chair, the proposed High Commissioner as a Vice-chair and, for example, the Ministers of MoHE, MCTI, ZICTA, the Ministry of Mines and Mineral Development (MMMD), MOH, and the Ministries of Agriculture and Livestock and Fisheries, as board members.

6.2. Strengthening the country's STI capabilities and structures

Zambia's STI capacity in academia, public research, and in firms and industries, requires greater policy support and better policy organization to develop and pull the country forward. Five areas are suggested for action. Each area faces common issues and the challenges of slowing growth, as well as resource limitation, due to Zambia's precarious external debt position and resulting domestic financial austerity. The current COVID-19 pandemic adds its own difficulties.

First, reform is needed in the higher education sector. Both the university and TVET systems require a rethink. Making institutions respond better to the needs of the economy and, more broadly, of society and the environment, needs to be a priority. This requires institutions to change their perceptions about the demand for diverse human capacities and competencies. It also requires a deepening of collaboration between academia and industry. Currently, curriculum development is based on the inertia of past practices and insufficiently researched assumptions. There is nominal participation of

beneficiary institutions and no follow-up with graduates to gauge their experience in the job market and as professionals.

Secondly, due to limitations in available resources for R&D, a condition that will be resolved only after the overwhelming macro issues are overcome, several important actions will need to be taken.

- **A comprehensive audit of all R&D programmes and activities that includes not only objectives and actions, but also verified and established research capabilities and financial resources.** The audit should cover all private and public institutions in all social and economic sectors and activities. The objective of such an exercise is to identify and merge activities and their resources, where sufficient programme similarities allow.
- **Immediate action on the defining of R&D priorities, following on immediately from the R&D audit.** Zambia is not lacking in institutional development. However, each and every supportive institution has a spectrum of activities. From the perspective of key developmental challenges, and the SDGs more broadly, a graded list of priorities should be defined and those at the bottom of the list considered for postponement when stronger macroeconomic and budgetary circumstances appear. The involvement of experts from international organizations and development partners can be an advantage

Third, The R&D audit will fit well into two more strategic actions.

- **The conduct of a technology assessment exercise. The assessment would research the social, environmental and economic impact of technologies that are available immediately or in the near future and which may be of importance for Zambia.** The assessment would also assist in the prioritization of support, either through R&D support, or support to innovative firms and industries as well as public agencies delivering services to Zambian citizens.
- **The conduct of an STI policy road-mapping exercise. This is a critical issue for Zambia, where policy development and promulgation require speeding up.** Technologies, particularly digital, frontier and Fourth Industrial Revolution technologies, are developing at an accelerating pace. Policy must strive to be one step ahead in developing and implementing specific policy tools that support positive outcomes and deter setbacks, particularly in the context of the SDGs.

Fourth, as noted above, a Zambia Innovation Agency should be considered. This national agency would support all forms of innovative projects emerging from start-ups or established firms, from rural communities, from university/business cooperation, etc., throughout the nation, beyond Lusaka and the Copperbelt. Adhering to international best practice, seed money for *proof-of-concept* or feasibility exploration projects should be awarded using a defined selection system that favours innovative, market-relevant and commercially viable outcomes. Should a project prove promising and profitable, subsidies provided may be reimbursed and used to fund new applicants. Joint requests, involving firms, researchers and inventors should be encouraged, or even stipulated.

The NTBC, which already follows this model, may be integrated in such an agency as a primary pillar and seed activity. This agency should have, from establishment, strong linkages and outreach to each province, accompanied with enough delegation of responsibilities and autonomy of allocation on minimal amounts of resources for proposals. The agency should be managed by a board, chaired at the highest level and vice-chaired by the proposed High Commissioner of STI.

Fifth, and finally, Zambia would benefit from a comprehensive, national audit of all policy tools, laws and regulations that affect STI. This would include fiscal measures and technical regulations relevant to all economic sectors, as well as technical regulations and standards that affect social and individual wellbeing and the natural environment. Special attention would be paid to the regulatory environment governing the operation of SMEs and start-ups and supporting structures, such as incubators and accelerators.

There is a widespread notion that many start-ups in Zambia fail to take off due to regulatory burdens and obligations in fees and taxes charged before significant revenues or earnings develop. While the facts of the matter need to be researched before a qualified verdict is established, it is somewhat symptomatic that the most prominent new firms have been in digital technology and FinTech, where capital investment is minimal and the flexibility of scaling up or down through expanding or contracting human resources is a straightforward exercise.

PART II:
Development challenges for STI

7. Gender and STI

7.1. Introduction

Women in Zambia lag "… behind their male counterparts in all spheres of national development" (NGP, 2014). In 2020, Zambia ranked 146 out of 189 on the Gender Inequality Index.[50] For Zambia to become a, "… Nation with a Competitive Economy and Innovative People" by 2030, as proposed in NDP7, gender mainstreaming must occur in all fields of STI. In its 2006 National Information and Communication Technology Policy (NICTP), the Government is clear on its understanding that the exclusion of women from development activities will prevent the achievement of sustainable development. Yet, in 2021, the evidence available suggests the potential held by women remains an untapped resource.

7.2. Gender policy and STI in Zambia

7.2.1. 2014 National Gender Policy - NGP

Women's emancipation and supportive gender policy is well established in Zambia. As a signatory to both CEDAW and Beijing +20 (FAO, 2018), Zambia aims in its NGP to repeal gender-discriminative legislation and increase women's access to and control over productive resources, such as land and financing, as well as STI. In the NGP, a clear mandate is given to relevant line ministries to mainstream gender in all operations. The NGP sets priority areas of action at the national, provincial, district and community levels, and plans to address shortcomings, such as the limited understanding of gender mainstreaming among implementing institutions, inadequate M&E and policy implementation frameworks, and limited co-ordination between ministries and government agencies. The NGP makes clear that if measures to change the picture are to be sustainable, they must work at, "… transforming mind sets as well as removing negative attitudes and cultural practices." The emancipation of women is solidly established on the socio-economic development agenda in Zambia. What is required is action and implementation.[51]

Strengthening funding and institutional capacity is needed for policies to succeed and make a difference. By its 2019 Annual Report, the Ministry of Gender (MoG) was facing, "… inadequate capacity to implement gender programmes countrywide due to lean structure at the Ministry." It also reported problems in planning and budgeting, as well as funding and transport issues that affected programme implementation and outreach (MoG, 2019).

The Ministry's response to these shortcomings includes planned revisions to the 2014 NGP (MoG, 2019). The revised policy will adhere to the SDGs. It will be, "… broader, utilising more integrated and multi sectoral approaches", and will align with NDP7. In the meantime, the Government reasserts its commitment in NDP7 to, "… coordinating and monitoring implementation of the National Gender Policy, to have 'meaningful impact' on the lives of women and girls."

7.2.2. Gender in STI policy

Zambia's STI policy recognizes the need for greater involvement of women in all STI processes. Tailored support to increase access and use of technology will be required for particularly disadvantaged women in rural communities. Already the 1996 STI Policy declared the objective of integrating gender, "… at all levels of the Science and Technology development process." Unfortunately, 24 years later, the new 2020 STI Policy reports that girls' and women's involvement in STI remains low. The barriers also remain the same: among them, cultural attitudes and misconceptions about the different suitability of various subjects for girls and boys to study. To realize the revised STI policy's objectives to promote the participation of women and girls by 2030 more needs to be done to drive women's progress in the next ten years than has been done in the preceding 24.

NDP7 acknowledges that disparities exist not only between men and women, but also between rural or urban locations, as well as *within* urban locations with pockets of poverty. Providing spaces for women to participate in innovation is important, but rural women and girls need support tailored to their needs that may differ from the opportunities on offer in cities, and these in turn need to be sustainable. For rural women in particular, traditional attitudes to their societal role restrict their potential. Before progress can be made in any individual sector, the broader cultural landscape into which girls are born must be fairer.

Lower ICT literacy and limited access to ICT products and services among women are key challenges for gender inclusion. Ongoing initiatives focus on training as well as ensuring the participation of women in policymaking processes. NICTP of 2006 identifies the challenges of low ICT literacy among women, limited access to ICT products and services, and a variety of barriers to women becoming entrepreneurs. The NICTP recognizes the potential of ICTs to be used, "… as

an instrument to mainstream youth and women issues in all activities of the economy and society." Despite positive strategies planned for implementing gender-sensitive measures, such as incentives targeted at female SME entrepreneurs, ICT training programmes and start-up/incubator projects for women, policy planning inclusion, and access to ICT tools and services in rural areas, there are few outcomes reported since the policy was enacted in 2006.

Zambia's Information and Communications Technologies Authority (ZICTA) is notable in that outcomes of gender-responsive ICT activities have been reported and presented in its 2019 Annual Report. In addition to collecting sex-disaggregated data,[52] ZICTA established a Gender and ICT portfolio, in collaboration with the Ministry of Gender and UNDP, "… to strategize on how best gender and ICT issues could be integrated in the Authority's corporate focus areas" (ZICTA, 2019). This collaboration resulted in the Authority's incorporation into the Programme on the Advancement of Gender Equity and Equality in Zambia (PAGEEZ). This in turn resulted in the draft of a National Gender and ICT strategy, and identification of potential sites for ICT hubs for women and girls in three rural provinces (ZICTA, 2019). Public policy initiatives will need to be complemented by private sector and civil society activities and may mutually benefit from a certain level of coordination and collaboration, as well as sharing of experiences and lessons learned. Box 5 describes a few examples.

Box 5: BongoHive and gender action

Founded in 2011, BongoHive is Zambia's first technology and innovation hub, seeking to address skills, coordination and productivity gaps within the local technology industry. BongoHive has evolved to assist scalable start-ups by creating opportunities for growth, networking, collaboration, exchange of ideas, and reduction in the barriers to entrepreneurship: its workshops and events are all aimed at, "… making Zambia Africa's next hotbed of innovation."

One of BongoHive's programmes is the Standard Chartered Women in Technology Incubator (WiT) Zambia: "Africa's leading incubator programme for female-run and founded businesses." It provides Zambian women entrepreneurs support in areas of business operations, digitization and digital transformation, accounting and financial management. WiT provides a three-month incubation programme followed by a six-month acceleration programme.

A 2018 study on inclusive innovation involving BongoHive indicated heightened complexities of gender inequality, not only between men and women, but between urban women and rural women. A study of female hub members found those from wealthy urban backgrounds expressed confidence and ambition towards an unconventional goal, such as developing mobile shopping and agriculture apps. One such member described BongoHive as, "…an inclusive space that welcomes women" (Jiménez, 2018). By contrast, those from poorer and rural backgrounds showed less confidence and had ambitions tailored by gendered expectations of women. One such member described the hub as a male-dominated space: "… men act like the space is theirs" (Jiménez, 2018). Evidently, the same hub is the locale of two contrasting socio-economic experiences of Zambian womanhood in relation to technology.

Source: bongohive.co.zm, scwomenintech.co.zm, *and Jiménez (2018).*

7.3. Challenges in achieving parity

Awareness building and leadership in addressing gender-relevant social norms and attitudes are critical for progress on Zambia's women empowerment and gender equality. NDP7 recognizes that Zambia is "patriarchal in nature" and that discriminatory practices and laws, "… prevent women taking agency for themselves and create barriers to transformative change." Entrenched attitudes towards women should first be addressed in government if top-down policies are expected to have any effect in rural areas, or in any individual economic sector.

A 2016 study of women in Zambian politics found that growing economic insecurity had shifted labour

division in both public and private realms, resulting in more women in the workforce and more men sharing domestic roles at home. Gender stereotypes are, "… weakening, due to growing flexibility in gender divisions of labour" (Evans, 2016). This has challenged presumptions about cultural expectations and enhanced, "… women's resolve to engage politically [as women are] increasingly perceived as equally capable of leadership" (Evans, 2016). Such shifts in perceptions present an opportunity for Zambia to achieve the 50 per cent political representation of women aimed at in the NGP. Underscoring this is MoG (2019), asserting the need for social cultural and behaviour re-setting.

Zambia has achieved gender parity in primary school enrolment. The challenge lies in retaining girls and women in education and graduating them into STEM professions. The NGP states that, "… equitable access to quality education and skills development will in turn translate into enhanced human capital for sustainable national development." Educated women tend to be healthier, participate more in the formal labour market, and can take on more demanding entrepreneurial roles.[53]

While UNESCO reports significant improvements in education access and participation of girls and women in Zambia, important disparities between urban and rural regions present serious challenges. The UNESCO Gender Parity Index (GPI) – an index designed to measure the relative access to education of males and females – is indicative of the current situation. Lusaka has recorded the highest GPI of 97 per cent, compared to the rest of the provinces, which ranged from 56 per cent in Northern Province to 83 per cent in Western Province. This indicates regional disparities largely analogous to the degree of urbanization (NGP, 2014).

Results in secondary and tertiary education are more variable. The issues attributed to poor retention of girls moving from primary onto secondary and onwards to higher education include high poverty levels, child marriages, teenage pregnancies, inadequate sanitation facilities and a lack of role models, particularly for girls in rural areas (UNESCO, 2016). However, the gender balances in tertiary education enrolment slightly favour women (see table 1 in chapter 3).

Parity in education does not necessarily translate into parity in research institutions. Examining the reasons why and adjusting incentives to remedy such imbalances are needed. Despite parity in enrolment, women were recorded as constituting 30 per cent of academic researchers (UNESCO, 2015). Efforts by the Government to encourage women and girls to take up STI subjects include the building of girls' technical secondary schools and the conversion of boys' technical schools into co-educational institutions. Through the GEWEL project, MoG developed the Keeping Girls in School (KGS) programme. KGS aims to increase access to secondary education for disadvantaged adolescent girls. In the period under review, the Project's target of 14,000 girls for whom school fees would have been paid was exceeded. Meaningfully harnessing technology in the service of gender equality, fees were transferred using the Government's Social Cash Transfer Scheme and paid the tuition for 16,239 girls (MoG, 2019). Box 6 describes, from a personal perspective, the challenges of being a women researcher in Zambia.

Box 6: Sombo Makeche – a role model recognized by the Network of African Science

The 2017 NASAC publication hailing women in science across Africa, aimed at inspiring girls and women to take up the sciences, highlights the journey and success of Ms. Sombo Makeche of Mulungushi University in Zambia. Among the first women to be given the overall best graduating student award in the School of Agricultural Sciences at the University of Zambia, Sombo's conviction that nothing is limited only to men informed her decision to take up a career in science. Ms. Makeche is motivated by the possibility of improving the livelihoods of people in her country.

Among Ms. Makeche's most impactful projects is her analysis of trader behaviour in the maize marketing system, the findings of which revealed how traders exploit smallholder farmers by paying lower prices than wholesalers and millers. A separate FAO report identifies this practice as an area that in turn impacts negatively on women (FAO, 2018). They are the primary producers and net buyers of maize, and yet brokers are usually men, and they create an environment of intimidation that deters women from marketing their products (FAO, 2018). Her subsequent recommendations had an influence on policy, positively impacting on the functioning of markets to the benefit of the farmers.

Asked about her own role models, Ms. Makeche mentions Dr. Judith Lungu, Vice Chancellor of Mulungushi University, an animal scientist who developed better ways of rearing livestock that prevents diseases and reduces livestock mortality rates.

Ms. Makeche faced many challenges, including funding barriers, gender-based feelings of inadequacy, as well as men taking credit for her work and being unfairly considered before men for positions. Nevertheless, she says: "… girls need to know that they can do so much more than they imagine; their power lies in their determination, hard work and self-belief."

Source: NASAC – Women in Science; https://bit.ly/3eUNu17.

While health issues are a serious burden for the emancipation of women in the development context of Zambia, the innovative use of ICTs and e-Health platforms can ameliorate the situation to some extent. However, they cannot replace gender responsive primary health care services. The country's high-disease burden of both communicable and non-communicable diseases especially impact women and girls (NGP, 2014). The most recent figure for the country's Maternal Mortality Rate (MMR) records 183 deaths per 100,000 live births,[54] among the highest maternal mortality rates in Africa (UNESCO, 2016). Among the reported factors contributing to this high rate are teenage pregnancies, distance to health services, and shortages of skilled health personnel, among others (NGP, 2014).

The Government released an e-Health Strategy for 2017-2021 in which it expresses its understanding of the potential for ICT and digital services to transform delivery of medical care and training. A partnership with Virtual Doctors to deliver telemedicine services was established in 2016.[55] Yet, despite the NGP stating how relevant ministries must ensure the development and implementation of gender responsive primary health care services, and the prominent mention of telehealth in the National Health Strategic Plan (NHSP) 2017-2021, there is no specific plan for gender in the Strategy and how these potentially transformative services must be harnessed for women's health.

Box 7: Gender and telehealth – the example of SPIDER

According to The Swedish Program for ICT in Developing Regions (SPIDER), which works to digitalize international development, Zambia has the second highest rate of cervical cancer in the world, and identified by the NHSP as the most common cancer in women in the country. In 2017, SPIDER launched a report to discover how telehealth, described as, "… the distribution of health-related services and information via electronic information and telecommunication," might screen and treat affected women in Zambia. The report identified challenges but shared the positive news that connectivity is already sufficient to support services in some regions. In its report, SPIDER recommends implementing a framework informed by local needs, and forming a coalition of telehealth stakeholders. The report's findings point also to the transformative possibilities of 'femtech' which, according to UN Women (2019), "… is estimated to grow into a $50 billion industry by 2025."

Source: spidercenter.org

Partnership and collaborative strategies, involving a broad spectrum of STI and gender stakeholders may be needed to overcome the ongoing lack of public resources, currently made worse by the COVID-19 pandemic and debt crisis. CSOs, NGOs, international organizations and development partners all have a role to play in improving facilities and circumstances for women's health. Box 7 describes research that confirms the potential for technological innovation in women's health using ICTs.

Access to reliable water and energy infrastructures greatly enhances the safety, health and productivity of women and their families. Only 4 per cent of households in rural Zambia use piped water. Women and girls are customarily required to spend time and effort hauling water for their households. Beyond exposure to aggression during hauling and the resulting physical and mental harm, fetching water takes up time that could be used for education, caregiving, and employment. Whether hauling water for consumption or using unsafe sources in underserved urban or peri-urban areas, a lack of quality potable water increases the risk of child diarrhoeal disease and stunting, as well as maternal stress.[56] The NGP requests that the relevant ministries ensure local councils meet the sanitation needs of women and girls in any new buildings and housing schemes and emphasizes the need for women's participation in consultation and planning. Available technologies for sourcing water and ensuring potable quality are well-known and are implementable through various models. These include provision through public investment in piping, as well as through localized entrepreneurship-based franchise schemes like jibu.com, which operates in seven African countries including Zambia.[57]

Biomass (wood and charcoal) is the main energy source in Zambian households, especially in rural areas. However, deforestation has forced travel across ever-longer distances to source it. While NDP7 plans to target ways to make electricity generation more sustainable and with improved access in rural areas, the generation and grid infrastructure build-out process is long-term.

Appropriate STI solutions are available now for most of the challenges listed above. It's frameworks and incentives for implementation that are needed.

7.4. Economic empowerment and STI

7.4.1. Access to knowledge, technology and finance

Given the slow change in attitudes towards women's land ownership, refocusing the gender empowerment agenda towards knowledge, technology and entrepreneurship provides a possible alternative strategy. UNCTAD has identified the ingredients for economic empowerment for women and men as equal access to education, training, markets and services, use of public funds, land and ownership rights, control over productive resources and access to technology, and ownership of income from one's own labour (UNCTAD, 2011). However, the main economic asset for most Zambians – agricultural land – is out of reach for most women.

Access to knowledge and technology and increasing access to skills and tools in support of small and micro enterprises (SME) is an important capacity development activity for women (UNCTAD, 2011). This is particularly true in Zambia where more than

50 per cent MSMEs are managed by women (NGP, 2014). Limited access to formal employment, lack of education and skills, and pressures created by reproductive roles, are all constraints that make the informal sector the only livelihood option for many women. These constraints are reinforced by a lack of supported entrepreneurship development, poor financial inclusion, and barriers to accessing markets, technology, and innovation opportunities (NGP, 2014).

Access to finance and financial services, and the knowledge of financial management, powered by ICTs and mobile money technologies and platforms, introduces game-changing empowerment for women. Recent successes include the Supporting Women's Livelihoods component of the NGP, which provides grants, mentoring, and facilitation of savings groups for a total of 75,000 women in 51 districts, among other activities. Training was also given in basic entrepreneurship, record keeping, and financial literacy, equipping, "… women led cooperatives with skills and knowledge to initiate and run enterprises" (MoG, 2019).

According to UN Women, "[w]hen a mother has control over her family's money, her children are 20% more likely to survive" (UN Women, 2019). Empowering women financially secures a country's future and has the potential to revolutionize development across multiple sectors. An example of funding for gender outcomes is the credit agreement signed in 2020 between the Government and the World Bank for additional financing to support Girls Education and Women's Empowerment (GEWEL). Launched in 2015, as well as supporting adolescent girls in secondary school, GEWEL increases access to livelihood support for women, empowering, "… girls and women during two critical phases of their lives."[58] Since its inception, GEWEL has supported 75,000 poor women in Zambia with life and business skills training, mentorship, and supported savings.[59] The GEWEL Project also supports regular cash transfers through the Government's social cash transfer programme.

The spread of mobile banking has proved to be a critical tool for financial inclusion of women (UNCTAD, 2011). It provides a method for distributing welfare, access to credit and financial transfers and other services, otherwise not accessible by financially excluded women, most of whom live in rural areas. Mobile money accounting can also play a significant role in gathering sex-disaggregated data. However, policymakers must take care that existing inequalities are not mapped onto opportunities for digital and financial inclusion for women. This is certainly a regulatory issue and policymakers will need to find ways to deal with customary law and other aspects of discriminatory behaviour engrained in local traditions.

7.4.2. Gender and innovation in agriculture

Land ownership for most women in Zambia remains a formidable challenge. Still, upgrading agricultural knowledge and technology will improve rural livelihoods for all and may lessen the physical burdens of female field workers. The National Agricultural Policy (NAP) 2012-2030 explains that women in Zambia make up approximately 80 per cent of the producers of food and 60.6 per cent of agricultural labour. Agriculture is also the source of 87 per cent of rural women's livelihood. Despite the sheer volumes of women engaged in agriculture, they face numerous constraints, revealing a picture of vast untapped potential for the sector. Unfair land acquisition opportunities and land ownership is a significant barrier to women moving beyond subsistence agriculture in Zambia. The Government passed a policy in ,000 designed to ensure at least 30 per cent of land allocations were reserved for women, with the remaining 70 per cent open to both men and women. Yet there is no codified law that governs land administration in customary areas, which effectively prevents women from exercising their rights (NGP, 2014). In 2017, a USAID customary land and tenure assessment detailed women's land rights under both the matrilineal and patrilineal systems in Zambia, and the ways to account for these in the making of new land laws. So far, no new laws have been made.

NDP7 acknowledges that development in the sector is, "…critical for achieving diversification, economic growth and poverty reduction." However, these aims are only achievable if the potential offered by women is unlocked. A 2010 gender audit of the Ministry of Agriculture and Livestock (MAL) identified a "… general lack of knowledge regarding the concept of gender throughout the ministry." The 2015 Linking Women with Agribusiness in Zambia report notes how, "… government agencies have limited knowledge and evidence of the role played by women in agriculture." If the agriculture sector in Zambia is to prepare for technological upgrading, it must empower its female workforce.

NDP7 calls its development aims for the agricultural sector value chain 'holistic'. However, they will only be so if they aim for gender equality. To remedy internal ambivalence to gender inequality and address resistance to gender policy in rural areas, government must lead by example, as it has in the Agricultural Development and Value Chain Enhancement (ADVANCE) Project (MoG, 2019). Targeting all 288 chiefdoms in Zambia, the initiative provides equipment for mechanized agriculture production and value addition to women-led cooperatives. So far, ADVANCE has provided ploughs and irrigation pumps

to increase agricultural productivity for 27 women-led cooperatives in three provinces (MoG, 2019).

A multistakeholder approach to improving gender equality in agriculture may hold greater promise by involving public partners, international organizations and development partners, as well as CSOs, NGOs and private sector firms and industries, many of which may have a corporate social responsibility agenda and a wish to engage. The Linking Women with Agribusinesses report (World Bank, 2015) highlights the potential of CSOs and NGOs in sharing, "… approaches and tools they have been using to mobilize women." The services and products that CSOs can provide include, "… specialized training in gender mainstreaming, leadership, entrepreneurship development, agricultural and environmental skills, community organization, [and] negotiation skills." Across the agribusiness sector there are a variety of different players who recognize that the gender gap in African agriculture represents an untapped opportunity. Organizations like Gender in Agribusiness Investments in Africa (GAIA) work towards channelling that potential and meeting industry needs by directing a gender-lens in agribusiness investments and offering a database of bankable agro-tech business ideas ready for scaleup and commercialization. GAIA aims to deploy agriculture technologies thoughtfully so that they bridge gender gaps, "rather than exacerbate already-existing inequalities".[60] Other recent activities in Zambia include a 2017 innovation boot camp held by the African Women in Agricultural Research and Development (AWARD).[61]

In 2016, the Zambian Women in Agricultural Research and Development (ZaWARD) was established, using the AWARD model. ZaWARD's objectives are to diversify the agriculture sector, assist the technological upgrading of smallholder farmers, and promote implementation of innovative technologies for sustainable development. ZaWARD's activities include the gender mainstreaming of all agricultural policy development and implementation, providing mentorship to girls and women, and linking to career enhancement opportunities such as funding, job openings and internships.

Private sector STI stakeholders are also getting involved. The World Bank finds that some food and agro-industry companies, such as Cargill Zambia, KASCOL and Zambia Breweries, are working to improve opportunities for Zambian women in agribusiness (World Bank, 2015). Among other activities, Cargill is registering two new microbanks, providing credit and savings facilities, piloted as cooperatives. It has formed women's clubs, a representative of which is on the board of each microbank, and a number of these same clubs have negotiated and received land from village chiefs. The results point to a positive experience of using collective power of an organized group of women to engage in a wider array of entrepreneurial activities.

While change in agriculture may be slow, combining gender and agriculture policy to drive change may be a more workable perspective. Government implementation of programmes and actions should necessarily examine entrepreneurship-based approaches for implementation. The above experiences provide some guidance that policymakers and public agencies should consider in the implementation of their own programmes. The first is to understand and embrace the notion that the agriculture sector has capacity for driving social change in terms of gender emancipation and gender equality. The second is that, in addition to mainstream social programmes, the use of entrepreneurship models can be effective in gender mainstreaming as well as overall development of rural and peri-urban communicates. Finally, certain experiences in women entrepreneurship underscore how a collective and organized framework for gender emancipation can, in practice, complement approaches that address individual needs and circumstance.

7.4.3. Women in mining

Advances in production and safety technologies are driving women's growing participation in mining. However, a lack of data makes gender assessments and policy formulation difficult. Copper mining accounts for 70 per cent of Zambia's foreign export earnings, is a key recipient of FDI, and is a dominant source of employment in several regions. Given its importance, it follows that mining should be a gender-inclusive industry. Yet, a recent report (Phiri and Chileshe, 2015) could not identify a single mining company with a documented gender policy. With the management of Mopani and Konkola mines reverting to the Government, however, Zambia now has an opportunity to provide a model of best-practice and ensure gender inclusion through the design and implementation of a sector gender policy. The policy should obligate the collection of gender disaggregated data in the industry. The mining industry is a difficult sector to regulate as a lack of transparency in governance, financing, and marketing, masks other collateral inequalities, including gender.[62]

The organization Mining for Zambia notes the moves in country to include women in the industry: bursaries, training programmes and the Kansanshi Mine's sponsorship of an all-female intake in 2017 are all

positive activities. Although women's participation across the sector is low, women are most present in small-scale mining, as well as artisanal mining of minerals and gemstones. For example, the Association of Zambian Women in Mining (AZWIM), established in the 1980s, has won contracts with Canada and China (Weldegiorgis, 2018).

Advances in technology are the most important factors driving women's growing participation in mining. Technology and its greater demand for skills such as numeracy, literacy and problem-solving, increasingly attract women to mining.[63] Technology has also seen the mechanization of many labour-intensive tasks, improving safety and easing workloads for both men and women. However, research conducted with Kansanshi Mine workers between 2016 and 2019 (Musonda, 2020) revealed that technological improvements are an insufficient condition for asserting a place for women in mining, while increased workplace interaction between the genders is critical.

The presence of women in the workplace is as important in changing attitudes and improving cultural acceptance as any underlying technological advances. They are connected in a virtuous cycle. The study found that, "… (as) male miners became exposed to women performing masculine jobs, their perceptions began to change" (Musonda, 2020). Miners who worked with women day-to-day, "… came to question the dominant view that women lacked the physical strength to succeed in mining" (Musonda, 2020). The study, which followed three female miners, found their ability to adapt to the challenges of the environment earned them respect. As one mechanic put it, these women, "… know their job. If we had even ten of such women, the world would stop underrating women" (Musonda, 2020).

The research points to the importance of women's presence in *all* workplaces. It emphasizes the impact of their presence in spheres that are particularly male-dominated, potentially altering traditional perceptions of women's roles in industry, as workers and entrepreneurs. The increasing visibility of women in male-dominated workspaces creates a critical mass of exposure, altering both men's views of women and women's views of themselves (Evans 2016). By performing in professional roles previously presumed to be beyond women's abilities because of strong associations with masculinity, women are increasingly perceived as equally capable of leadership (Evans, 2016). It is perhaps because of this, politically important and far-reaching yet unrealized potential, that First Lady Esther Lungu herself has called for more women in the mining sector in the country.[64]

7.5. Recommendations

With a determined push to move towards gender equality in STI, Zambia can energize and accelerate its development process and address the challenge of attaining the SDGs. Some recommendations that can contribute to this are presented below:

RECOMMENDATION 1: **Review the National Gender Policy**

- **Update objectives, measures and instruments to gender-mainstream all sectors** and engender design of all areas of economic development, including in the mining sector.
- **Clearly define new ministry responsibilities**.
- Ensure that subsequent policy revisions have a **comprehensive and sustainable gender-sensitive plan for STI development** that can keep speed with the ever-changing STI environment.
- **Empower the Ministry of Gender with financing and logistics to effectively implement programmes**.

RECOMMENDATION 2: **Disaggregate data by gender**

- **Significantly increase the collection of data disaggregated by gender** across all sectors.
- **Bolster monitoring and evaluation using this data**. Without it, progress in equality cannot be tracked and correlations between cause and effect remain hidden, preventing design of 'relevant and targeted' interventions (FAO, 2018).
- **Reflect in data the urban/rural and inter-urban divides**.

RECOMMENDATION 3: **Gender-mainstream STI**

- **Promote women in innovation incubators and ensure designs and innovations are gender-sensitive and include women as end users** (UN Women, 2017), especially in areas of labour and health, where 'femtech' models used by NGOs and CSOs could simultaneously improve health and contribute economically.
- **Improve conditions for recruitment, retention, and advancement of women in STI fields.** This might include establishing collaborative networks and mentorship

programmes for female scientists and increasing the visibility of women in STI and entrepreneurial role models. However, it will also necessitate a commitment to broader improvements in health, sanitation, nutrition and education provision countrywide that create the grounds upon which a sturdy STI environment can be built.

RECOMMENDATION 4: **Address cultural attitudes and social norms in government**

- **Reform all discriminative legislation, including biased laws, land rights infringements, detrimental clauses and regulations**, "in close consultation with village chiefs, to ensure that reforms take root at the local level" (World Bank Group, 2015).
- **Improve representation of women in government** through training, peer support, awareness-raising, mentoring, education, and policy reform that aims for gender equity in electoral system and governance structures, in preparation of national general elections in 2021.[65]
- **Address cultural attitudes and social norms in chiefdoms**.
- **Realize plans by the Ministry of Gender to intensify sensitizations in rural chiefdoms on gender equality, working with traditional leaders to become champions of gender equality** (NGP, 2014), and promote women in STI as role models in rural locations.
- **Make full use of ICTs and media, "to disseminate Anti Gender Based Violence messages"** (MoG Annual Report, 2019), utilizing the Ministry of Information and Broadcasting Services to gender-mainstream all media institutions, and facilitate public education on gender equality (NGP, 2014).

RECOMMENDATION 5: **Empower women economically and increase financial inclusion**

- **Engage in greater outreach and delivery of financial services to women**, together with commercial financial institutions and CSOs, especially in rural areas (World Bank Group, 2015).
- **Develop financial education programmes**, so women can 'gain confidence' and 'make informed financial decisions' (UN Women, 2019).
- **Make all policy sensitive to gender and locality**, with focus on rural women and girls. Realize plans in NDP7 to expand rural road networks to improve access to education, and offer women entrepreneurs better access to markets, services and agribusiness opportunities (World Bank Group, 2015).
- **Map the financial, technological, geographical, behavioural and cultural elements, impacting women's demand for digital financial services** to inform their policies and programmes (UN Women, 2019).
- **Enable women to organize and form groups and cooperatives**, which facilitates access to loans through group-based mechanisms, as well as more formal support and empowerment programmes from government or donors (World Bank Group 2015).
- **Endorse a gender-sensitive school curriculum** that tackles reductive stereotypes both in relation to STI and more broadly, and promotes gender role models in professional fields.
- **Increase inclusion and retention of girls through secondary and tertiary education**, including improvements to sanitation facilities, public transport and roads.
- **Step-up efforts during COVID-19 pandemic**. Efforts to achieve gender equality must not be reduced or side-lined during the pandemic. The country's economic recovery will depend upon a commitment to women's inclusion in all sectors and industries. Any pause in the progress towards equality will be detrimental to the country's long-term development.

8. Digital transformation and digitalization

8.1. Digitalization and digital transformation

Zambia has made significant progress in its digital infrastructure. There is growth in the number of digital tech start-ups, entrepreneurs and hubs, while digital technology has seen application in solar energy, agriculture, public service delivery, and financial inclusion. As COVID-19 continues to impact the world, slow growth in almost every sector is disrupting systems and transforming livelihoods. One aspect that has become increasingly important is the role of digital technologies and digitalization. Zambia has made significant progress in digital

infrastructure and digital platforms, and growth in the number of digital tech start-ups, entrepreneurs, and hubs. Digital technology has seen application in solar energy, agriculture, financial inclusion, and public service delivery. Progress in these areas provides a good foundation for the Government of Zambia to leverage its COVID-19 pandemic recovery efforts and address the country's sovereign debt challenges (World Bank, 2020b; see also UNCDF, 2019a).

Policymakers need to understand the transformational impact of digital technologies, and respond with policies that maximize the benefits for all Zambian society, while mitigating downsides.

Digital technologies and digitalization can play important roles in Zambia's transformation and supporting the realization of NDP7 and Vision 2030.[66] From reducing poverty to achieving the SDGs, from increasing productivity in firms and industries to improving the efficiency and effectiveness in governance, digital technologies play important roles (World Bank, 2020a). Digitalization offers opportunities for countries to leapfrog, connect to global value chains, address development challenges in line with the SDGs, and enhance resilience across systems, sectors, structures and societies (OECD, 2018; AU, 2019).

Figure 10: Leveraging digital innovation to achieve the NDP7 Targets and SDGs in Zambia

NDP7 Targets	Digital Transformation Effects	Impact on the Economy	Key SDGs Impacted
• Good Governance • Strong Human Capital • Favourable Business Climate	• Accelerated enhancement of human capital through greater access to data and knowledge facilitated by digital platforms • Accelerated enhancement of human capital through greater access to data and knowledge facilitated by digital platforms • Greater access to markets and financial services through reduced transaction costs and increased competition facilitated by digital platforms	• Reduced development inequality • Enhanced human development • (health and education) • Diversified economy and job creation (agriculture, mining, tourism, energy, transport, ICT) • Reduced poverty and vulnerability • diversified economy	• SDGs 3, 4, 5, 8, 9, 10, 13 • SDGs 1, 2, 3, 4, 5 • SDGs 7, 8, 9, 11 • SDGs 1, 2, 3, 4, 5 • SDGs 7, 8, 9, 11

Source: Compilation based on MoNDP (2017) and World Bank (2020).

In realization of these opportunities, key stakeholders have recommended that the government of Zambia, "… develop a digital transformation strategy that will support its goal of meeting NDP7 targets and improve the country's fiscal space" (World Bank, 2020b).[67] An important aspect of this recommendation is the emphasis on the use of digital technologies and digitalization to strengthen operations in the public sector by improving efficiency and effectiveness, increase productivity in the private sector, and improve governance in the form of accountability in both the public and private sectors (World Bank, 2020a/b).[68] As figure 10 describes, the application of digitalization in these areas speaks directly to NDP7 targets, while also helping to address the SDGs.

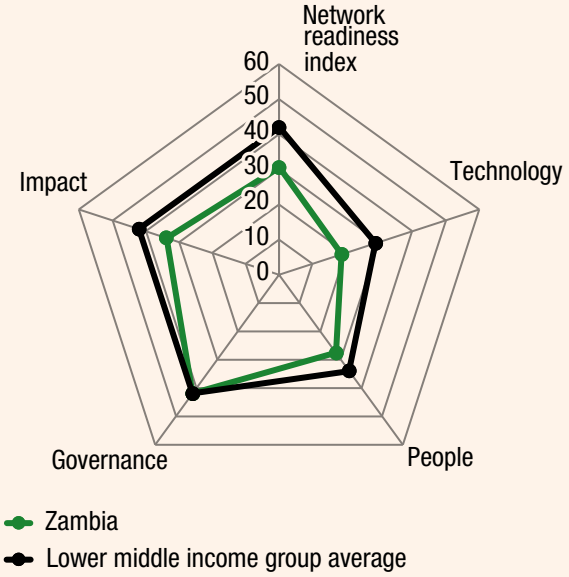
Digital transformation requires diverse technological skills and capabilities, and regulatory frameworks that govern data use and ensure privacy, promote appropriate ethical standards and maintain focus on the SDGs. Policies that foster digitalization (AU, 2019), governance, collaboration and partnerships (Daniels *et al.*, 2020a) are a vital component of the digital landscape.

8.2. Digital infrastructure and network readiness

In terms of fibre-optic coverage, the focus is the corridor between Chililabombwe, through the Copperbelt onto Lusaka, while Western Zambia is underserved. Progress in digital technologies and digitalization depends on the build-out of reliable, accessible and pervasive network infrastructure. The network readiness index describes the overall situation in Zambia with respect to digital infrastructure (see box 8).[69] Table 3 indicates the state of digitalization in Zambia reflected in the country's position to comparators within the region. Zambia's score of 116 indicates a need for greater effort in improving the country's digitalization prospects.

Box 8: Zambia Network Readiness Index

	Rank (out of 134)	Score
Network readiness index	116	30.54
A. Technology pillar	**123**	**18.76**
1st sub-pillar: Access	118	28.27
2nd sub-pillar: Content	124	8.15
3rd sub-pillar: Future Technologies	98	19.85
B. People pillar	**116**	**27.68**
1st sub-pillar: Individuals	114	26.88
2nd sub-pillar: Businesses	70	41.05
3rd sub-pillar: Governments	131	15.11
C. Governance pillar	**103**	**41.95**
1st sub-pillar: Trust	88	30.51
2nd sub-pillar: Regulation	90	56.75
3rd sub-pillar: Inclusion	119	38.59
D. Impact pillar	**121**	**33.75**
1st sub-pillar: Economy	108	14.45
2nd sub-pillar: Quality of Life	129	31.90
3rd sub-pillar: SDG Contribution	96	54.90



Source: Based on Dutta and Lanvin, 2020

Table 3: Network Readiness Index – Zambia compared to countries in the region

	2020 Ranking	Technology	People	Governance	Impact
South Africa	76	64	83	52	109
Kenya	82	99	78	51	104
Botswana	99	91	102	99	105
Namibia	103	93	98	105	106
Tanzania	110	117	112	83	114
Uganda	114	112	121	90	129
Zambia	116	123	116	103	121
Zimbabwe	126	122	118	124	132
Mozambique	128	126	127	121	130

Source: Based on Dutta and Lanvin, 2020

Zambia has achieved a significant increase in the use of mobile phones, attaining 18.6 million subscriptions in 2020, with 55 per cent of those using broadband. Tables 4 and 5 track the evolution of Internet and telephony use and provide key indicators for ICT use with comparators. The importance of mobile telephony cannot be understated. Both in commerce and governance, as well as in everyday communal and private life, mobile communications have become an indispensable utility.

Table 4: Telephony and Internet indicators

	2012	2014	2016	2018	2019	2020
Fixed-telephone subscriptions	82,542	114,420	101,407	100,444	96,719	72,129
Fixed-telephone subscriptions 100 inhabitants	0.57	0.74	0.62	0.58	0.54	0.39
Fixed-broadband subscriptions	14,999	20,521	31,784	72,228	88,891	97,877
Fixed broadband subscriptions per 100 inhabitants	0.10	0.13	0.19	0.42	0.50	0.53
Mobile-cellular telephone subscriptions	10,524,676	10,114,867	12,017,034	15,470,270	17,220,607	18,619,952
Mobile-cellular subscriptions per 100 inhabitants	72.76	65.68	73.44	89.16	96.41	1.1.20
Active mobile-broadband subscriptions	2,314,983	3,741,615	5,156,284	8,346,609	9,140,666	10,123,890
Active mobile-broadband subscriptions per 100 inhabitants	17.20	24.20	32.40	49.40	52.60	55.02

Source: ITU

With a steady growth of digital infrastructure, Zambia is shifting focus towards ensuring that the infrastructure is effectively utilized, improving reliability and addressing issues of infrastructure security. The continuing growth in mobile telephony is attributed to increased investments in telecommunication coverage infrastructure, heightened competition among the service providers, and the increased adoption of machine-to-machine services, such as point of sale machines and other data-enabled devices that utilize SIM cards (ZICTA, 2020). With this level of digital infrastructure in place, the government of Zambia is now shifting focus towards ensuring that the infrastructure is effectively utilized, as well as improving reliability and addressing issues of infrastructure security.

Progress in the sector has contributed to making mobile services more affordable, with prices dropping by about 55 per cent since 2015. However, compared to several African and other developing countries, Zambia's telecom services industry has lost its relative advantage in terms of affordability (see table 6). ZICTA and ZAMTEL would be well-advised to explore policies and actions taken by their peers in Uganda, Rwanda or Ethiopia, that have enabled more drastic reductions in prices of mobile telephony. However, key challenges remain unresolved, among which electricity supply is perhaps the most critical for digitalization.

Table 5: Key ICT indicators

Key indicators ICT (2017)	Zambia	Africa	World
Fixed-telephone sub. per 100 inhab.	0.60	0.90	13.00
Mobile-cellular sub. per 100 inhab.	78.60	74.40	103.60
Active mobile-broadband sub. per 100 inhab.	45.20	24.80	61.90
3G coverage (% of population)	53.00	62.70	87.90
LTE/WiMAX coverage (% of population)	43.40	28.40	76.30
Individuals using the Internet (%)	27.90	22.10	48.60
Households with a computer (%)	8.80	8.90	47.10

Key indicators ICT (2017)	Zambia	Africa	World
Households with Internet access (%)	16.60	19.40	54.70
International bandwidth per Internet user (kbit/s)	5.40	11.20	76.60
Fixed-broadband sub. per 100 inhab.	0.20	0.60	13.60
Fixed-broadband sub. by speed tiers, % distribution			
up to 256 kbit/s to 2 Mbit/s	52.20	38.70	4.20
up to 2 to 10 Mbit/s	45.60	37.20	13.20
equal to or above 10 Mbit/s	2.20	24.10	82.60

Source: ITU

Table 6: Price of prepaid mobile telephony and 1Gb data (% of GNI per capita, $)

	2015	2016	2017	2018	2019	2020
Thailand	2.27	1.19	1.31	1.22	1.14	1.02
Ecuador	6.58	4.12	6.11	2.04	1.96	2.00
Kenya	9.72	4.33	4.01	4.05	3.10	2.62
Rwanda	20.16	8.42	3.87	4.66	3.39	3.44
Tanzania	8.74	6.25	5.83	5.76	5.11	4.77
Ethiopia	19.63	13.53	9.65	5.77	5.28	5.01
Uganda	27.71	15.33	16.20	8.07	7.75	5.95
Zambia	14.94	12.25	12.25	3.88	3.27	6.65

Source: https://a4ai.org/extra/baskets/A4AI/2020/mobile_broadband_pricing_gni

In terms of fibreoptic coverage, Western Zambia is underserved, while the focus is, unsurprisingly, the corridor between Chililabombwe, through the Copperbelt onto Lusaka. Public investment has linked provincial centres to a fibre-optic backbone, enabling Internet connectivity and broadband access. Rural areas are served mostly through the state-owned power company ZESCO, which provides fibre-optic infrastructure and, to some extent, the state-owned ZAMTEL telecom operator.

Under the SMART Zambia project implemented by the Zambia Information and Communication Technology Authority (ZICTA), the first data centre, INFRATEL, was launched in early 2017. The objective is to develop the national broadband system to bolster public service delivery. Today, INFRATEL operates three data centres which offer services to both public and private sector entities. INFRATEL also operates more than 1,000 communication towers, cloud services, and a country-wide fibre-optic network, to provide telecommunications infrastructures as a service.[70] The data centre project was implemented in cooperation with Huawei and with financial support from the Chinese Government.[71]

8.3. Digital innovation system: policies, actors and stakeholders

An innovation systems approach is needed to tackle the broad scope of legislation and regulation to decrease policy fragmentation, improve policy coherence and linkages and stimulate private sector involvement beyond pure commerce and towards funding and collaborating on various R&D projects and initiatives. The fundamentals for digitalization in Zambia are good, as actors and institutions are in place and accompanied by high levels of positivity, vibrancy and entrepreneurial energy. The Government has engaged with development partners in recent years as an early adopter of digitalization (EC, 2018). It is currently implementing the World Bank's Digital Economy for Africa (DE4A) Initiative,[72] which supports

Africa's transformation through digitalization. National initiatives such as the Smart Zambia Institute (SMI),[73] which carries the mandate for the SMART Zambia project, are broadly supported. A range of institutions, from the Bank of Zambia to ZICTA, ZAMTEL, ZECSO, and others, are intent on mustering digital technologies and applications to produce positive development impacts and transformative change.

From a system of innovation perspective, it is important to involve all stakeholders that benefit or are impacted by digital technologies. In Zambia these would include governance related to digital identities (GSMA, 2019), finance (UNCDF, 2019b),[74] healthcare systems,[75] and agriculture. Agriculture presents particular opportunities for food systems and logistics, including after-harvest management, as well as climate-smart agriculture (World Bank, 2015; World Bank Group, 2017; World Bank, 2019, 2020c). Other sectors with transformation potential include manufacturing, mining, tourism, fisheries, climate change, environment and biodiversity, and energy – opening up opportunities in smart-grid, or the possibility of Zambia becoming a net-exporter.

8.4. Challenges for digitalization

The key challenge of digitalization in Zambia is enabling digital entrepreneurship, education, capabilities and skills, and funding. To unlock these potentials many key challenges will need to be addressed. Some of the challenges operate at the level of individual sectors. Other challenges are more generalized and permeate all sectors. The key challenges of digitalization in Zambia include an enabling business environment for digital entrepreneurship, education, capabilities and skills, and funding.

8.4.1. Enabling business environment

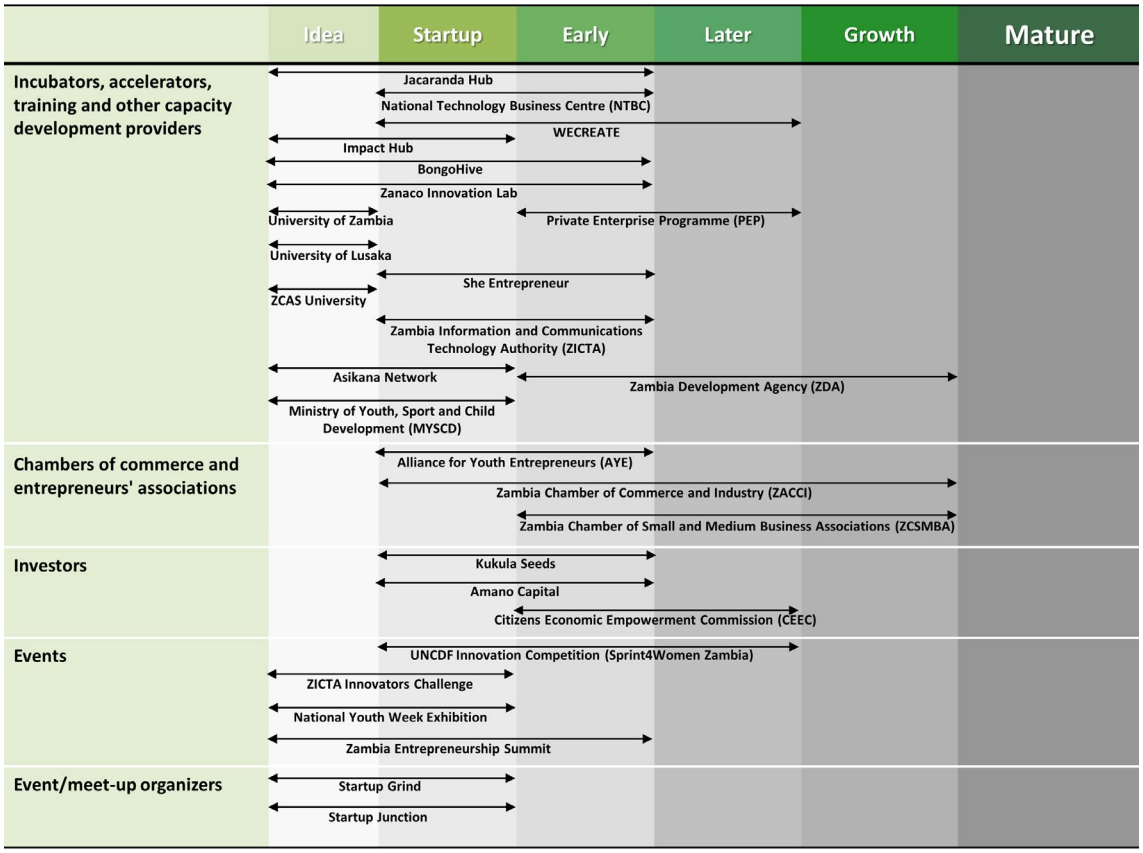
A favourable business climate is essential for digital transformation to contribute to Zambia's development agenda. Digital technology entrepreneurs and innovators require support structures such as incubators, accelerators and clustering (STI-oriented business parks) as well as fiscal demands that are commensurate to their development stage.

A positive development was the establishment of the National Technology Business Centre (NTBC), to support innovators and SMEs through activities that include technology scouting and by acting as a technology enabler. However, the NTBC itself faces challenges in delivering on these objectives. These include difficulties with commercialization and scaling up, misalignment of the demand and supply side and, due to factors that include low absorptive capacity and misalignment of the research and industry agenda, limited uptake of innovation and digital technologies by the private sector. A conceptual challenge is to move away from considering STI propositions as having to start from an advantageously perceived resource base – whether agricultural or mineral. Digital technology propositions by their very nature often look into resolving inefficiencies in existing processes (finance, logistics, trade, etc.) and are based on a ubiquitous resource – educated and skilled people.

Interventions in this regard can focus on increasing business support centres for digital technology industry actors, entrepreneurs and innovation ecosystems actors, increased funding, improved governance, and policies and regulations. Organizations such as BongoHive,[76] FinTech4U,[77] Jacaradna Hub,[78] and Impact Hub[79] accelerators and innovation hubs have developed to satisfy a need for entrepreneurship support. Figure 11 describes the start-up and entrepreneurship ecosystem in Zambia.

Entrepreneurship is a key factor in development and support for entrepreneurs in digital and other sectors is growing. Entrepreneurship is increasingly seen as a key factor in development and the number of institutions supporting entrepreneurs in digital and other sectors is growing. The challenge is to weaken silos and increase collaboration. The main disincentive for collaboration is competition for the same funding sources. The entrepreneurship support ecosystem consists mainly of incubators and government agencies and focuses largely on supporting entrepreneurs who are at the concept and early stages. While business training is available, the quality of the training content is not certified against any standards. Support service targeting later-phase and growth phases of start-up development is also lacking.

Figure 11: Technology ecosystem actors by category and business stage



Source: ITC (2017)

There are two key challenges for incubators and accelerators (ITC, 2019). The first is to reach out to entrepreneurs beyond Lusaka and the Copperbelt. Here, public-private partnerships and joint action is a clear winning strategy. The second is the limited interaction between accelerators and incubators and the nation's universities and academic research institutes. This has two important consequences. First, students are not as well informed as they could be about the challenges and opportunities of entrepreneurship. Second, students have few opportunities to discover the nature of real-world demand that can drive digital development and transformation.

Support organizations can be either public or private sector initiatives, but the linkages remain weak. Government institutions may invite more prominent actors, such as BongoHive, to events aimed at awareness building or to collaborate on research projects that engage development partners and international organizations (ITC, 2017). However, follow-up actions need to be energized through a determined implementation of policy – primarily of the newly promulgated 2020 STI Policy.

8.4.2. Human capabilities, skills and education

Interaction between universities and TVET schools with firms and industries requires systematic policy support. The review of curriculum in subjects relevant for digital technologies should become an ongoing activity to match the development of both technologies and how beneficiaries use digital technologies. Discussions with STI stakeholders during the UNCTAD mission indicate that there is a critical need to increase education in STEM disciplines. Enrolment needs to be encouraged more strongly while preparations for education and professions in STEM fields need to start early, perhaps even at primary levels. Digital and technology entrepreneurs indicated that there is an acute skills gap in the quality of graduates emerging from universities and TVET schools. Skills and knowledge were largely theoretical. Firms often had to retrain employees coming straight from school or university which, for a considerable time, made them a pure cost to doing business. The low skills base renders most graduates unable to meet the skills demand, in particular in the digital technology sector. Addressing the education, capabilities and skills gap is therefore an area for urgent attention.

On their own initiative, several firms interviewed by the UNCTAD mission offer internships and use the period of unpaid interning (sometimes with support for transport and food) to preselect future employees. However, a formal and mandated interaction between universities and TVET schools with firms and industries to generate internships during studies needs to be more deeply considered. There is, as well, an on-going need to refresh or introduce new curriculum in subjects relevant for digital technologies. Such issues are indicative of weak networks and interactions within the innovation and digital ecosystem.

Another area of vital importance where initial progress has been made is in the provision of Internet and specialized ICT services supporting research in academia on a non-profit basis. The Zambia Research and Education Network (ZAMREN) is the national provider of inter-institutional connectivity. By connecting researchers to the Regional Research and Education Network (RREN) in Eastern, Central and Southern Africa, through the UbuntuNet Alliance, ZAMREN extends into other national research and education networks in Africa and the rest of the world. Its Eduroam service allows users from participating institutions to remotely gain secure network access to their institutions.[80]

8.4.3. Funding

Funding is a significant challenge for digital entrepreneurs. Prohibitively high interest rates aside, other challenges included a lack of deal flow, limited expertise in venture capital management and weak demand for local innovation. Although interviews during the UNCTAD missions indicate that digital technology entrepreneurs in Zambia no longer consider finance as the main or only obstacle, funding remains a primary and inescapable input. Financing solutions, such as crowdfunding platforms, angel investor networks and venture capitals are in short supply, especially for the start-up and early phases.

This is a common problem in many African countries, but in Zambia the challenge is more acute as there is only one fund investing in the sub $100,000 range – Zenga Ventures – and only one fund investing in the $100,000–$500,000 range – Kukula Seed Fund (ITC, 2019). Other investors that have been recently active in Zambia include GDMA, Ground Squirrel Ventures, Barclays Bank, Hivos Impact Capital, UNCDF, Zambia National Commercial Bank, and Financial Sector Deepening Zambia. This dearth of investment contrasts with the strong growth of investor activity across Africa (World Bank, 2019).

Funding relationships are not all about the money. Several important and additional conditions become apparent when establishing a financial relationship with an investor. One is that entrepreneurs, who are often technologists or engineers, must acquire soft skills that enable them to develop a clear vision about the merits of their innovation. They need to organize teams with the required diverse competencies, and they must develop a convincing pitch. Another requirement is for entrepreneurs to achieve a certain level of financial literacy. Common elements to this effect include, financial management, investment concepts, insurances and taxation. Knowledge, behaviours and attitudes of entrepreneurs about money increases the likelihood of obtaining funding from investors.

Despite the fact that the 1996 STI Policy promoted the establishment of a Venture Capital Fund for technology, none materialized, "due to inconsistencies in the S&T Act No. 26 of 1997" (MoHE, 2020). Other challenges noted included a lack of deal flow, limited expertise in venture capital management and weak demand for local innovation. The policy, however, did establish a Technology Business Development Fund (TBDF), which is managed by the NTBC. It has modest financial means. However, in August 2020, it did call for financing proposals for innovations aimed at mitigating the effects of COVID-19 or contributing to the fight against it.

The Zambia Innovation Agency proposed by this review could act as a funding institution in early phases where private investors may not find interest, or in sectors where developmental impact is high even if return on investment is below that available from investing in government bonds. The proposed establishment of the Agency will face the challenge of sustaining a flow of investable proposals from the digital technology sector. To develop a positive deal flow, important efforts will need to be made in enhancing linkages and relationships with all STI stakeholders, and in particular with academia and private sector firms and industries.

8.5. Opportunities for digital innovation

Digitalization provides many opportunities for transformational impact. Some of these opportunities include using digital technologies to improve farming and food systems, and advancing the financial inclusion of marginalized people through mobile money FinTechs, e-commerce and e-government.

8.5.1. Agriculture and digital technologies

Given the importance of agriculture in Zambia in terms of employment, and strategically in terms of food security, its digital transformation should receive the highest policy priority. There are several challenges in Zambia that well-designed policy support can help overcome. Among them is the relatively high cost of ICT services from a rural perspective, as well as weakening access quality with increasing distance from the Lusaka and Copperbelt regions. A low level of digital literacy can be addressed by government policy and programmes. Loadshedding – which means power outages for regions and sectors seen as non-critical, including in rural agriculture – limits the use of ICTs (Phiri and Bala, 2020).

Local authorities will require support from competent programmes and agencies to develop programmes of action specifically designed to meet the digital technology needs of farmers, extension workers and traders of agricultural produce and farming supplies. Timely access to information is key for all phases of growing and production cycles.

The Zambia Integrated Agricultural Management Information Systems (ZIAMIS) provides access to e-vouchers and other forms of support, such as e-extension, insurance, crop forecasting, marketing and financial services.[81] Private sector initiatives and entrepreneurial approaches may be inherently more sustainable, as the incentives do not evaporate once project funding from, for example, development partners, runs out. Box 9 describes the evolution of the e-commerce platform eMsika as an example of a private sector digitalization in the agricultural sector.

Box 9: Digitalization in Agriculture and Food Systems: eMsika

According to Gilbert Mwale, CEO of eMsika, "… there are 60 agriculture suppliers that supply to 1.3 million farmers and 2,500 Agro dealers across Zambia, making the ratio of suppliers to farmers be 1:7,000. Most of these suppliers are based in Lusaka!"[82] In other words, they are not present in rural areas where farming is the main economic activity. Adding to this problem is the low number of extension workers per farm of 1:2,000 and the relatively low value of farm produce which does not allow many farmers to hire a professional farming manager.[83]

To remedy this situation eMsika's e-commerce operations offer small-scale farmers in rural areas access to seeds, fertilizer, agrochemicals and equipment. Payments are made using mobile money or credit cards and products are delivered to the farms. Remote consultation services are also provided on demand. The founders of eMsika, whose families grew maize and tobacco, established that one of the biggest challenges for improving agricultural productivity and earnings was better access to quality farm inputs. To date, eMsika has reached 1,200 farmers, six agro-dealers, and 17 agricultural input suppliers.[84] eMsika looks forward to the advantages that the regional trade agreements provide to scale up activities.[85]

Source: World Bank 2020a

8.5.2. FinTech in Zambia

In Zambia, digitalization has contributed immensely to financial inclusion, especially in rural areas, with a financial inclusion rate of 50 per cent compared to 70 per cent in urban areas.[86] FinTech in Zambia has recorded annual growth rates of up to 93 per cent in the transaction volume of agents (MoF, 2017; see box 10 below). There are indications that since 2015, in terms of, "access and usage of digital finance in Zambia [FinTech] has increased more than fivefold."[87] This transformation in financial services provides evidence of development acceleration that involves both formal and informal actors (mostly in the rural areas) and stakeholders from the digital and non-digital sectors. Digitalization is helping to accelerate development in Zambia (World Bank, 2020a).

As noted in box 10, the rise from $10,000 in 2016 to $5.2 million 2017 in transactions between banks and Mobile Network Operators typifies progress that is not only transformative but also revolutionary. In addition, the percentage of adults with an active digital financial service account has risen from 2 per cent in 2014 to 24 per cent in 2017 UNCDF (2018). Evidently, digitalization is helping to address the needs of Zambia's population, who previously did not

have bank accounts, especially citizens in rural and remote parts of the country. Such transformations have impacted favourably on the SDGs (discussed later in the section) by improving inclusion and contributing to the global agenda of 'leaving no one behind'.

Box 10: Progress in Digital Financial Services (FinTech) in Zambia

As of December 2017, there were 18 FinTech providers in Zambia. In 2017, the industry saw the launch of the third FinTech by a Mobile Network Operator (MNO), Zamtel Kwacha. The merger of BancABC and Finance Bank, as Atlas Mara, was also launched. The FinTech providers in Zambia include the following:

- Banks/Microfinance institutions (BMIs): Atlas Mara, Barclays Bank, Ecobank, FINCA, First National Bank, Indo Zambia Bank, Investrust Bank, Standard Chartered Bank, United Bank for Africa and Zambia National Commercial Bank (better known as Zanaco)
- MNOs Airtel, Mobile Telephone Networks (better known as MTN) and Zamtel
- Third-party providers: cGrate, Spargris (Kazang), SpeedPay, Zambia Postal Services Corporation (better known as ZamPost) and Zoona

Although the Zambian FinTech market continues to be heavily dominated by first-generation products such as person-to-person transfers, airtime purchases, bill (utility) payments, bulk payments and cash-in and cash-out transactions, the country is starting to see more uses for second-generation products such as pay-as-you-go solar services and merchant payments. In December 2017, more than $5.2 million was transacted between bank accounts and MNO customer wallets, up from less than $10,000 in December 2016.

Source: UNCDF (2018)

With these foundations in digital infrastructure, finance and other aspects now in place, Zambia is better positioned to strategically leverage digitalization. This includes, for example, digital payments in both the public and private sectors and involving formal and informal actors in urban and rural areas. As the government of Zambia notes, digital payments are, "… critical today when contactless transactions and rapid transmission of funds to the vulnerable are vital to Zambia's COVID-19 resilience."[88]

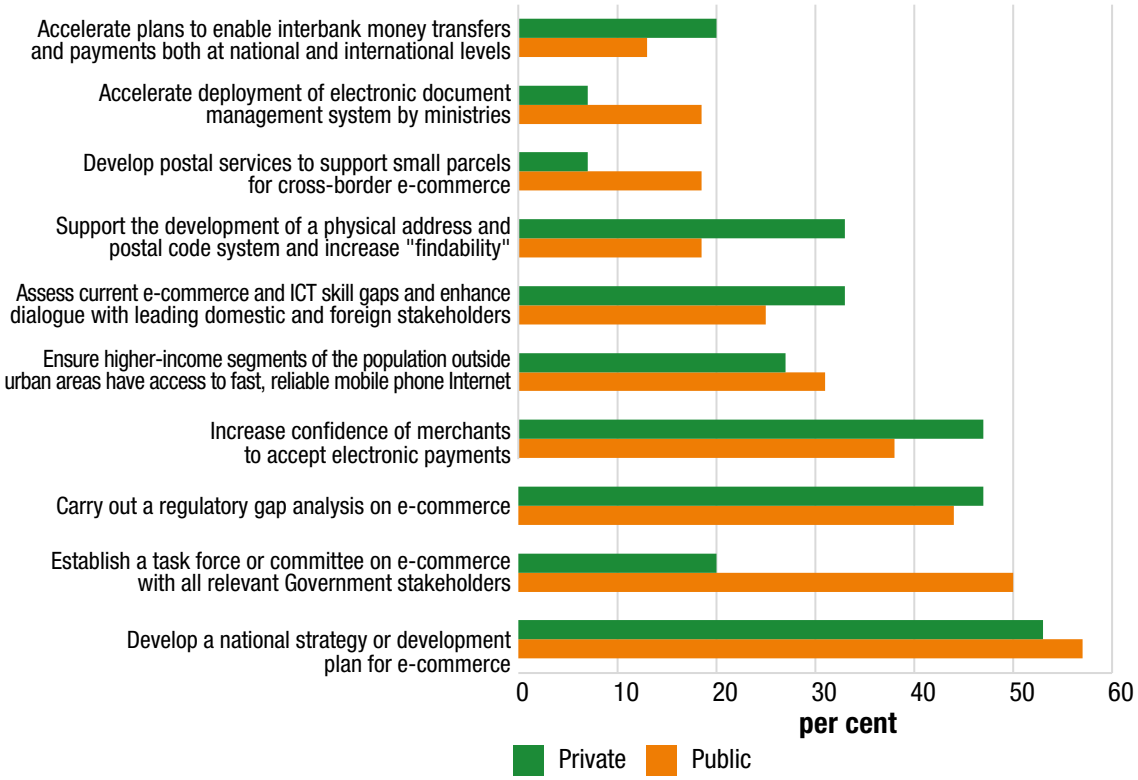
8.5.3. E-commerce

The COVID-19 pandemic, while causing a downturn of overall economic activity, provided an opportunity for e-commerce firms in Zambia to scale up operations, expanding their client base as well as the country's network of business partners and suppliers. Other sectors, like tourism, which faced a hard pause, may have taken the opportunity to branch out into other services, such as vehicle rental and transport, as well as improving and strengthening their online presence.[89]

The pandemic also increased costs for all businesses, including e-commerce firms, due to measures taken to protect staff. A weakening economy resulted in the devaluation of the ZMW and thereby drove up the price of imports, including motorbikes, which are the primary delivery vehicle in the Zambian e-commerce sector. Other challenges remained as in pre-COVID-19 days, including poor access to the Internet and electricity, and the high cost of broadband services.

UNCTAD's e-Trade Readiness Assessment for Zambia, conducted in 2018, noted substantive progress and recommended measures across seven key policy areas. The eTrade Readiness Assessment focuses on addressing seven relevant policy areas: e-commerce readiness and strategy formulation; ICT infrastructure and services; trade logistics and trade facilitation; payment solutions; legal and regulatory frameworks; e-commerce skills development; and access to financing (UNCTAD, 2018). Based on the eTrade Readiness Assessment, figure 12 summarizes key actions and recommendations to help enhance e-commerce in Zambia.

Figure 12: Key actions to enhance e-commerce in Zambia



Source: UNCTAD (2018).

8.5.4. E-government

An important activity that may benefit from digitalization, and is directly under the purview of the Government is improving productivity and effectiveness and reducing costs of governance in public service delivery. E-government is identified as an important element for socio-economic development in the 2006 ICT Policy Vision 2030 aspirations. This is complemented by the SMART Zambia proposal to shift governance and administration to digital service delivery.

The main strategic challenge will be – given the growing but still relatively underdeveloped ICT infrastructure and digital literacy – reaching out to rural regions. At a more practical level, the availability of a well-educated and digitally capable workforce is an important asset. However, competent civil servants must contend with limited publicity of e-government services driving low usage, inadequate e-government services, lack of ICT training opportunities, and the low or non-existent budget lines for digital technology within ministries and agencies (Sikaonga and Tembo, 2020).

8.6. Recommendations for harnessing opportunities in digital technologies

Interventions, strategies, regulations or digital policies that Zambia may choose to develop to foster digitalization and exploit the opportunities should be clearly represented in the future NDP8. Guidance is needed to respond to the transformational pressures of digitalization, to ensure that digital opportunities are available to all. Failing to do this will reinforce existing inequalities. Policy makers may consider the following recommendations:

RECOMMENDATION 1**: Zambia should move to an innovation system framework for developing, coordinating, implementing, and evaluating digital and STI policies.**

This means **increasing efforts to develop linkages, communication and collaboration** among key digital innovation stakeholders in government, academia, firms and industries, development partners, NGOs and CSOs.

RECOMMENDATION 2: **Zambia should maintain and even increase its pace of investment in its digital infrastructure.**

Defining a **digital infrastructure roadmap** may help in developing partnerships and securing funding. The rural-urban divide is acute and threatens to hold back the country in its entirety.

RECOMMENDATION 3: **Zambia may wish to review the cluster governance system and decide where exactly the issue of digital transformation will receive the necessary attention.**

It may reconsider a more **collaborative engagement among concerned agencies**. Currently, the policy domain is seen as under the purview of MoTC and ZICTA. Whereas, at a minimum, the new Ministry of Technology and Science, MCTI, the Ministry of Finance, Bank of Zambia, the Ministry of Health, and the Ministry of Agriculture and the Ministry of Fisheries and Livestock all need to be involved. By coordinating and collaborating on activities, synergies will come about, and diverse competencies will contribute and lead to better outcomes.

RECOMMENDATION 4: **the business climate, while workable, deserves a deeper consideration, given that most digital firms and entrepreneurs are start-ups and SMEs.**

Agencies and institutions responsible for the provision of business support for digital transformation should **develop an enhanced capacity to understand innovation processes**, as well as digital transformation itself. Currently interaction and trust among digital innovation system actors and stakeholders is low.

RECOMMENDATION 5: **strengthen education, capabilities and skills as key inputs into the digital economy. The required capabilities are diverse. Beyond technological capacities, they include management and the related soft skills needed to run a firm.**

Among consumers, **digital literacy is an important stimulus for the demand for digital services** from firm and from government. Executives in public agencies such as, for example, the NTBC, TEVETA or PACRA, would benefit from capacity-building. Providing government agencies that are frontline STI stakeholders with capacity-building opportunities can be a valuable initiative and a point of collaboration with development partners and international organizations.

RECOMMENDATION 6: **improve the availability of funding for digital transformation. This is related to the depth of the conviction about whether digital transformation and STI more generally, matters for the Zambian economy and society.**

Funding is important equally for digital start-ups and supporting institutions, as well as for academic and research institutes. Successful funding outcomes require strong collaborations and deep engagement among public and private stakeholders.

RECOMMENDATION 7: **whatever the interventions, strategies, regulations or policies that Zambia might formulate to foster digitalization and exploit opportunities, these must be clearly represented in the future NDP8.**

To this end, probably the most urgent recommendation is to **develop a strategy among partnering institutions and stakeholders to drive the NDP8 development process towards a full recognition of STI** as a top-level development factor, with digital transformation as its current front-end and most impactful component.

9. Food system transformation and STI

9.1. Introduction

Universal and secure access to healthy food is one of the biggest policy concerns for Zambia. A systemic outlook is necessary to understand the challenges in food production and consumption and the interdependencies between food and other socio-technical systems such as health, water, energy, transport and the environment.[90] Agriculture in Zambia is in urgent need of transformation, including through technological upgrading and innovation-based development. The impacts of climate change, already posing existential threats to many rural communities in the country, are among the biggest challenges this transformation must overcome. STI is crucial for creating the knowledge base needed to navigate the complexity of the food system and for accelerating adoption of practical and sustainable innovations tackling local and global challenges.

9.2. Key challenges for transforming the food system

Delivering on the ambition of the 2030 Agenda will require an overhaul and transformation of food systems. Transforming food systems can help achieve other goals, including social goals such as tackling poverty (SDG1), improving health (SDG3) or gender equality (SDG5), as well as environmental goals such as tackling climate change (SDG13), and safeguarding ecosystems, biodiversity and forests (SDG15). There is a need also to ramp up investments in education (SDG4), industry, innovation and infrastructure (SDG9), and sustainable production and consumption (SDG12) to enable the transformation of the food system (see e.g., FAO, 2019). STI is key in fostering the process of transformation.

9.2.1. Food system perspective

Food systems encompass the entire range of actors and their activities in the production, aggregation, processing, distribution, consumption and disposal of food products that originate from agriculture, forestry or fisheries. Any food system is part of the broader economic, societal and natural environments in which it is embedded (FAO, 2018). The food system comprises sub-systems (e.g., farming, production, waste management) and multiple actors are involved across the value chain. The food system is embedded in and is inseparable from changes in other socio-technical systems (e.g., health, energy, water).

The transitional challenges faced by food systems are twofold (e.g., Marsder and Morley, 2014; Dixon *et al.*, 2020). First, there is an urgent need to make food systems more productive to ensure better access to healthy diets for growing populations. Second, food production and consumption need to become more sustainable to avoid the negative social and ecological impacts of intensive industrialized agriculture – such as pollution released into the air, soil and water – while making food production more resilient in the face of climate change.

9.2.2. Transition challenges for food system in Zambia

Key challenges for the Zambian food system include reducing malnutrition and improving food security, stimulating sustainable agriculture and food production, supporting inclusive rural development and resettlement and addressing environmental degradation and climate change. Seen through the lens of the food system, these challenges are closely interconnected. For example, the growing demand for food often leads to a growing demand for arable land, which in turn leads to deforestation and the loss of biodiversity. On the other hand, the growing demand for good quality and diversified diets may be met by improving agricultural practices in existing arable land, as well as by changing demand for specific foods.

Reducing malnutrition and food security

Rural Zambian diets are characterized by dependence on one staple crop – maize – and therefore suffer periods of seasonal scarcity. Food supply at a national level does not help the shift to more diverse and healthy diets as many of the traditional more nutritious foods are less available now than they were in previous decades (Harris *et al.*, 2019). Traditional diets based on 'nshima' (maize meal porridge) are still preferred by most Zambians. While providing meals that are high in starches, nshima is generally low in nutrients (Hivos and IIED, 2017). Children's diets are low in high-nutrient and animal-source foods due to many factors, such as their high cost, families' limited livestock holdings or a preference for selling rather than consuming livestock (ibid.).

Harris *et al.* (2019) summarize Zambia's nutrition transition as a story of inequality, with persisting malnutrition among the rural and urban poor, notably women and children, growing obesity among the urban rich as well as an increase in significant non-communicable diseases (NCDs) in adults, notably hypertension. Food frequency surveys reveal a lack of nutrient-dense foods (fruits, vegetables and animal products) in the diet of rural populations, mostly due to the increase in their prices compared to staples.

Stimulating sustainable agriculture and food production

Agriculture and food production in Zambia is undergoing a structural change. Agriculture accounted for 18.9 per cent of value added to GDP in 1999. It fell steadily and sharply to 2.9 per cent in 2019 (ZamStats online database). Almost half of all Zambians work in agriculture (48.5 per cent of employment in 2020), but the share of employment in agriculture has been decreasing at a fast pace since 2005 when more than 72.3 per cent of the population was employed in the sector (World Bank, 2020b). As the rural population is still growing, NDP7 expects agriculture to retain its central role in rural livelihoods and employment and anticipates a high supply of labour in the sector. The absolute numbers of workers in agriculture will put increasing pressure on natural resources or on urban labour markets.

The agricultural sector mainly depends on smallholder production using simple technologies and minimal levels of purchased inputs. Crop yields are constrained by low soil fertility and droughts (Branca *et al.*, 2021). There are 1.3 million farm households with a mean size of 3.27 ha. Zambia's smallholder farmers face severe challenges. They are highly vulnerable to climatic shocks, especially droughts, as they depend on rain-fed agriculture. They have limited access to high quality inputs (e.g., fertilizers), climate and post-harvest management information, reliable markets, farm management and risk management advice and financial support. Women constitute 64 per cent of the rural population and about 80 per cent of all food producers and poverty rates are generally higher among households headed by women.[91] The agro-food sector is constrained by inadequate and aging technical infrastructure including underdeveloped research and testing facilities, shortages of qualified staff, and low levels of investment and budget support (World Bank, 2020a).

Experts stress the importance of promoting diversity in the production of nutrient-rich foods in the country, such as fruits, vegetables and pulses (beyond soya for animal feed or export) and supporting supply chains which make these accessible and affordable (Harris *et al.*, 2019). Diversifying the production will require a systemic agricultural transformation that overhauls current practices in farm production and food markets.

Supporting inclusive rural development and resettlement

The structural shift towards expanding export-oriented commercial farming creates pressures for long-term local residents, especially women (Nolte, 2014; HRW, 2017). Rural settlers, in areas where commercial farms are introduced, face pressures to leave the land they cultivate and depend on. There is evidence of displacements of local populations following establishment of new and expanding commercial farms (HRW, 2017). The displacements have significant negative impacts on people's health, housing, livelihoods, food and water security, and children's education. When considering pathways for transforming the Zambian food system, including comparing available technology options and land management approaches, the Government should consider the economic, social and environmental implications of its choices, including those in resettlement management. These choices should recognize the human rights of local communities and ensure they are engaged in decisions concerning their future.

Addressing environmental challenges

Zambia faces multiple significant environmental challenges, notably climate crisis, deforestation and the loss of wildlife, air, water and ground pollution, poor waste management, and land degradation, notably in mining areas (ZEMA *et al.*, 2013; MNDP, 2017; 2020). The increased demand for land for agriculture and human settlement has led to rising surface and groundwater pollution of water resources, as well as widespread deforestation (ZEMA *et al.*, 2013; MNDP, 2020). The country has been losing its forested areas since 1990 (from 71 per cent in 1990 to 65.2 per cent in 2016). Deforestation has been caused by agricultural activities and the use of wood for fuel.

The impacts of climate change are increasingly severe. Zambia has been experiencing extreme weather conditions, such as droughts, rising temperatures and unpredictable rainfall patterns (MNDP, 2017). It is estimated that the impact of climate change will cost Zambia approximately 0.4 per cent of annual GDP growth for the foreseeable future. It is further estimated that without action, rainfall variability alone could lead to losses of 0.9 per cent of GDP growth over the next decade. The capacity and ability to adapt to effects of climate change remains low and endangers current and future food security.

9.3. STI for food system transformation in Zambia

STI-led development in the food system requires Zambia to consider and embrace climate smart agriculture as well as frugal innovation, business model innovation, digitalization of agriculture, increasing standards and greater international cooperation and partnerships.

9.3.1. Innovation opportunities to foster food system transformation

There are considerable opportunities for STI to foster transformation of the food system in Zambia. The reviewed literature and stakeholder interviews conducted for this review indicated several strengths and areas of opportunity which can foster the transformation of the Zambian food system. These include:

- **Increasing recognition of the potential of Climate Smart Agriculture** (CSA) to improve productivity and resilience, while reducing the need for fertilizers, including among foreign donors and investors (Branca *et al.*, 2021);

- Harnessing entrepreneurial attitudes and **frugal innovation potential** in the sector;
- Successful **innovation initiatives and partnerships** supported by specialized agro-food organizations, such as Musika,[92] or the Timbali Technology Incubator:[93]
- Using **financial business model innovations**, such as agricultural leasing, that reduces credit risk and improves access to equipment;[94]
- Emerging **business model innovations enabled by ICT** and the wider digitalization trend, such as improving access to market information, technical knowledge and digital extension services in rural areas;
- **Higher quality standards enforced within international supply chains**; and
- **International North-South collaborations**, such as the Dutch-funded AgriProFocus, (now Netherlands Food Partnership) and other regional partnerships.

In order to face sustainability challenges, research and innovation should strive for improving agricultural productivity, export potential and the quality of food products while ensuring that the food system is equitable and environmentally sustainable. Diffusing advanced technologies and land management systems has an important role in addressing sustainability challenges, especially on larger farms. Given the need to ensure a wide adoption of sustainable practices by smallholders, promoted solutions should be accessible and feasible for most of Zambia's farmers. This necessarily means prioritizing existing, effective and efficient low-cost technologies, especially when targeting smallholders, to achieve the SDG targets (Adenle, 2019).

Climate Smart Agriculture

The findings from recent scientific research see Climate Smart Agriculture (CSA) as a major area of opportunity to foster the transformation towards more sustainable and resilient food production in Zambia. CSA is a sustainable approach to agriculture which increases crop productivity in an environmentally sustainable and resilient way. CSA is based on accessible and affordable techniques and technologies that allow farmers to adapt their practices to the impacts of climate change and other environmental challenges.

Typical CSA approaches include conservational techniques for agriculture (such as, minimum soil disturbance, crop rotation, reduced use of chemical fertilizers), rainwater harvesting, or integrated soil fertility management (allowing for the reduced use of chemical fertilizers). There is a wide variety of such innovative approaches developed and tested in many southern African nations, including in Zambia. Support to CSA should be accompanied by capacity-building and raising public awareness on the adverse effects of climate change.

CSA reduces greenhouse gas emissions and increases soil carbon sequestration (Branca, 2021). At the same time, the adoption of minimum soil disturbance (MSD) technology significantly increases crop productivity and economic returns to smallholders, as well as improving land use efficiency. CSA methods can substitute or significantly reduce the need for chemical fertilizers, particularly in semi-arid areas. CSA has a potential to improve economic returns from farm output and reduce environmental burden from nitrogen losses compared to conventional farming (Abdulai and Abdulai, 2017).

Productivity increases depend on a combination of several CSA practices. For example, the combination of MSD with crop rotation for legumes had a significant positive fertilization effect on nitrogen-fixing (Abdulai and Abdulai, 2017; Branca *et al.*, 2021). That CSA is more labour-intensive than mechanized agriculture is one potentially challenging issue, and may lead to relatively higher production costs. To increase its adoption, the regulatory framework needs to include both positive incentives to shift to CSA as well as disincentives to discourage environmentally impactful agricultural techniques. Supporting CSA requires a portfolio of policies (see box 11).

Box 11: Designing policy portfolios for CSA

Branca *et al.* (2021) propose a comprehensive policy portfolio to foster wider diffusion of CSA in Zambia. In the short-term they recommend:

- Prioritizing the implementation of Minimal Soil Disturbance (MSD) systems in semi-arid areas, where the benefits of CSA are higher;
- Supporting research and extension to develop, test and promote CSA technology packages (given their potential to reduce crops' vulnerability to multiple risks) and encourage crop diversification;
- Enhancing access for smallholders to seed varieties suitable for varied agro-ecological zones, make fertilizers and herbicides more affordable to farmers (as they can exploit the CSA potential), and reduce transactional costs throughout the value chain via real-time market information;
- Supporting the development of markets for mechanization to deal with labour scarcity, which can reduce the implementation of labour-intensive MSD-based systems;
- Financing capacity-building and training programmes to strengthen farmers' knowledge about improved farm practices and strategically target younger farmers who are more open to CSA; and
- Considering different productivity levels associated with MSD-based technology uptake in different agro-climatic zones and related higher competition with conventional tillage-based systems.

In the longer period, policies to promote CSA uptake should:

- Enhance research programmes to develop CSA packages of practices suitable for enhancing the resilience of smallholder farming systems in different agro-ecological zones;
- Strengthen advice and monitoring capacity of agriculture extension programmes, including access to climate- and weather-related information;
- Invest in strategic rural infrastructure and logistics in areas more vulnerable to climate change, e.g., smallholder irrigation systems in semi-arid areas, and cooling and storage facilities to reduce post-harvest losses due to heat waves or floods; and
- Improve customary land security through registration or land certification to encourage CSA.

Source: Branca et al. (2021)

9.3.2. Challenges to mobilizing STI to foster food system transformation

While STI has the potential to foster transformation of the agro-food sector, the reviewed literature and stakeholder interviews confirm many barriers and systemic bottlenecks inhibiting sustainable innovation, listed as follows:

- **Limited policy and governance capacity** to foster food system innovation:
  - The lack of systemic perspective on the challenges of food system transformation.
  - Insufficient coordination of research and innovation activities focused on food system transformation within the Government.
  - Limited trust and weak collaboration between government and stakeholders, including donors and NGOs (Chapoto, 2014); limited coordination between NGOs.
  - Overdependence on foreign programmes in agricultural R&D and innovation, limitations to building capacity and learning from the received support (World Bank, 2020a).

- Limited representation of smallholders in policy processes (Adenle *et al.*, 2019).

Non-tariff barriers to exports, especially maize.

- **Insufficient innovation and absorptive capacity** of MSMEs in the agro-food sector:
  - Insufficient capacity of smallholders to absorb innovative practices and techniques, including limited business skills and formal education (Adenle *et al.*, 2019).
  - Limited investment in innovation and innovation diffusion in agriculture and food production, including in CSA (Burke *et al.*, 2019; World Bank, 2020a).
- **Weak policy support for smallholders and subsistence farms**:
  - Lack of affordable finance for smallholders, SMEs and local entrepreneurs.
  - Insecurity of land tenure and risk of resettlement faced by rural communities where commercial farms are planned (HRW, 2017).
- **Weak agro-food innovation and business advisory support systems**:
  - Insufficiently developed extension services, including in supporting technology diffusion by providing business and innovation support, as well as by getting engaged in applied research (see Burke *et al.*, 2019; World Bank, 2020a).
  - Underdeveloped and aging agro-food infrastructure (e.g., machinery, warehouses) and supporting infrastructures (e.g., poor quality of roads and rail transportation).
  - Weak national seed systems and challenges of seed registration (World Bank, 2020a).

The following sections discuss whether and how existing policies supporting research and innovation respond to the challenges and tap into the emerging STI opportunities.

9.4. STI policy and governance for transforming the food system

9.4.1. Food policy landscape

Positioning of food and food system change in NDP7

NDP7 proposes STI actions aimed at diversifying food production and improving productivity, integrating climate smart techniques, investing in irrigation technologies and infrastructure and investment in fish farming, including in training and research. Strengthening the agriculture sector and improving food security is among key strategic areas for development of Zambia in NDP7. It highlights a range of development opportunities to be unlocked by diversification, which is expected to help improve productivity and resilience, within the agriculture sector. The plan focuses on improving production and developing complete value chains of high value commodities with significant export potential, such as cashew nuts, coffee, maize, wheat, tea, cotton, sugar, fish, agro-forestry and livestock products, as well as other commodities to support the local manufacturing sector. Apart from high level objectives focused on food production and security, NDP7 addresses multiple issues related to the food system transformation across all five strategic areas and by numerous strategies and programmes (see table 7).

NDP7 proposes several STI actions aimed at diversifying food production and improving productivity in the agro-food sector. The plan underlines the necessity to integrate climate smart techniques to tackle the impacts of climate change and other environmental challenges, such as conservation farming, crop rotation, reduced use of chemical fertilizers and raising public awareness on the adverse effects of climate change. This is expected to help rural communities become more resilient to climate change. The plan calls for investment in irrigation technologies and infrastructure as a key intervention for increasing crop diversification, production and productivity. In relation to fisheries, it emphasizes the need for increased investment in fish farming technologies, sustainable management of capture fisheries and strengthening fisheries training and research.

The plan has a comprehensive approach to agricultural value chains recognizing the need for investment in production, processing and marketing, and distribution mechanisms. It mentions the need to strengthen the link between research and extension services to improve the quality of

product development and production. The plan also recognizes that the change will require investment in related infrastructures and technologies, notably in the areas of water management and aquaculture-related infrastructure, ICT, logistics, storage, cold chain and road infrastructure.

Policy areas with objectives and instruments promoting STI for food system transformation

Many ministries and government agencies have a role in designing policy for food production and consumption. However, Zambia's National STI policy (MoHE, 2020) is a reminder that productivity in agriculture has not significantly increased in the last decade mainly due to limited investment in science and technology. Nearly all key line ministries and government agencies have a role in designing and implementing instruments related to food production and consumption. These ministries include, most notably, the Ministry of Agriculture, the Ministry of Fisheries and Livestock, and the Ministry of Commerce, Trade and Industry. The Ministry of Agriculture has a particularly strong focus on agricultural R&D. The Ministry of Commerce, Trade and Industry has a strong focus on manufacturing and trade. Table 8 provides an overview of relevant policy areas for the food system, highlighting their objectives as relevant for the food system and STI-related activities.

9.4.2. Agricultural R&D and food production

Public support for agriculture in Zambia is principally in the form of subsidies implemented through the Food Reserve Agency and the Farmer Input Support Programme. The level of investment in agricultural R&D in Zambia remains relatively low. As of 2014 Zambia only invested 0.5 per cent of its agricultural GDP in agricultural research, half of the 1 per cent minimum recommended by the African Union and the United Nations. Zambia's National Agriculture Policy (MoA and MoFL, 2016) has a strong STI component. The policy has a high-level objective to strengthen agricultural R&D and innovation to support the overarching objectives of the policy.

The policy is implemented jointly by the Ministry of Agriculture and Ministry of Fisheries and Livestock. Public support for agriculture in Zambia is principally in the form of subsidies implemented through the Food Reserve Agency and the Farmer Input Support Programme (FISP). In 2019 these accounted for 51 per cent of agricultural spending in Zambia (IAPRI, 2019). Subsidy programmes are promoted at the expense of instruments supporting research, extension and infrastructure investments, which are all underfunded (Branca *et al.*, 2021).

A key question is whether the subsidy programmes are in line with the wider objectives of NDP7 and agriculture policy. For example, FISP is mainly targeting the production of maize, rather than fostering the Government's diversification strategy within the agricultural sector (PwC, 2021). Furthermore, based on farm management and household data with soil analysis, the use of fertilizer has been evaluated as unprofitable at commercial prices for many farms (Burke, 2019).

Currently the recommended application rate of fertilizer in Zambia is unique, despite heterogeneous soil and climate conditions in the country. Burke *et al.* (2019) recommend that policy should focus more on the appropriateness of the promoted technologies for the local context rather than encouraging the use of inputs. They also recommend a shift from subsidy programmes to investing in extension and adaptive research. This would enable farmers to raise the profitability of using fertilizer by adjusting its application rates and through managing their soils more effectively and sustainably. This shift away from centralized subsidies is aligned with CSA (Branca *et al.*, 2021).

Table 7: Mapping development outcomes and strategies relevant for food system transformation in 7NDP

Strategic area	Desired development outcomes	Strategies and programmes relevant for food system	Corresponding SDGs
Economic diversification and job creation	Development outcome 1: Diversified and export-oriented agriculture sector	Includes six strategies focused on food production and productivity, access to finance, agriculture value chains, diversification, infrastructure investment, and small-scale agriculture.	
	Development outcome 4: Improved energy production and distribution for sustainable development	Supporting renewable and alternative energy sources, including finding alternatives to charcoal in rural areas.	
	Development outcome 5: improved access to domestic, regional and international markets	Strategies on trade facilitation, international cooperation, improving logistics, enhancing the competitiveness of Zambian products, including agricultural products	
	Development outcome 6: improved transport systems and infrastructure	Focus on improving transport in rural areas, including for agriculture related activities.	
	Development outcome 7: improved water resources development and management	Focus on improving water resources and management, including for food production	
	Development outcome 8: enhanced information and communication technology	Focus on improving ICT infrastructure in rural areas which is key to the e-voucher system and access to finance	
	Development outcome 9: enhanced decent job opportunities in the economy	Promoting entrepreneurship, access to finance, and employment opportunities in rural areas, including in agriculture sector	
	Development outcome 10: enhanced research and development	Enhancing R&D and innovation capacity, including agriculture R&D	
Poverty and vulnerability reduction	Development outcome 1: Enhanced welfare and livelihoods of the poor and vulnerable	Includes a strategy focused on social protection programmes with specific actions on home grown school feeding, food security pack and farmer input support programme enhancement.	
Reducing development inequalities	Development outcome 1: Reduced inequalities	Includes strategies promoting integrated rural development, includes strategies on rural agricultural productivity enhancement; gender equality and enhancing income opportunities for poor and marginalised groups, often living out of subsistence agriculture.	
Enhancing human development	Development outcome 1: Improved health and health-related services	Includes a strategy focused on enhancing food security and nutrition, including support food and nutrition research and applied R&D promotion.	
	Development outcome 2: Improved education and skills development	Includes horizontal strategies focused on enhancing access to skills training presumably including skills relevant for agro-food sector as well as enhancing role of STI.	
	Development outcome 3: Improved access to water supply and sanitation	Includes strategies focused on water supply, sanitation and waste relevant for rural dwellers and farmers.	
Creating a conducive governance environment for diversified and inclusive economy	Development outcome 1: Improved policy environment	Focus on improving national data and information system, which should include data and indicators relevant for monitoring and evaluating the Zambian food system.	
	Development outcome 4: Improved service delivery	Includes strategies on land administration and management and capacity building of civil servant across policy areas and governance levels.	

The Ministry of Agriculture and the Ministry of Fisheries and Livestock manage agricultural R&D policy in Zambia. The policy includes strategies focused on promoting alternative sources of financing agricultural R&D, promoting PPPs in agricultural R&D, improving capacity to undertake appropriate research incorporating the effects of climate change, and promoting adaptive research (including research trials). The ministries aim to strengthen the research-extension-farmer linkages to improve agricultural production and productivity. The line ministries have control over agricultural R&D, with little coordination with MoHE. The ministries have their own breeding farms, serving as R&D and training facilities, located in all Zambian provinces.

The Ministry of Fisheries and Livestock runs the Zambia Aquaculture Enterprise Development Project. Its objective is to advance the aquaculture subsector as a viable and inclusive business opportunity. It does so by supporting improvements in production and productivity. The result will be improved livelihoods of beneficiaries – fish farmers and entrepreneurs, of whom 50 per cent are women – along the aquaculture value chain. The project is funded by the African Development Bank (AfDB).

The Ministry of Fisheries and Livestock also runs the Dairy Transformation Programme, which aims to scale up smallholder farmers and cooperatives into commercial production. It does so by upgrading production to increase the quality and quantity of milk to commercial levels. The project is supported through a development partnership with New Zealand.

The key question is whether these projects will result in commercially viable and sustainable activities once the financial support is exhausted. There have been seven other projects implemented since 2013. Evaluations of their technological, commercial or environmental sustainability several years after termination, however, have not been conducted. Opportunities for policy learning from past and current projects are available and should be taken advantage of.[95]

The level of investment in agricultural R&D in Zambia remains relatively low (see figure 13). Agricultural research spending in Zambia grew by 70 per cent during 2008–2014, mainly as a result of a large influx of funding through a World Bank loan – associated with the Agricultural Productivity Programme for Southern Africa (APPSA)[96] – as well as additional donor contributions. Despite this strong growth, as of 2014 Zambia only invested 0.5 per cent of its agricultural GDP in agricultural research, half of the 1 per cent minimum recommended by the African Union and the United Nations (ASTI and ZARI, 2016).

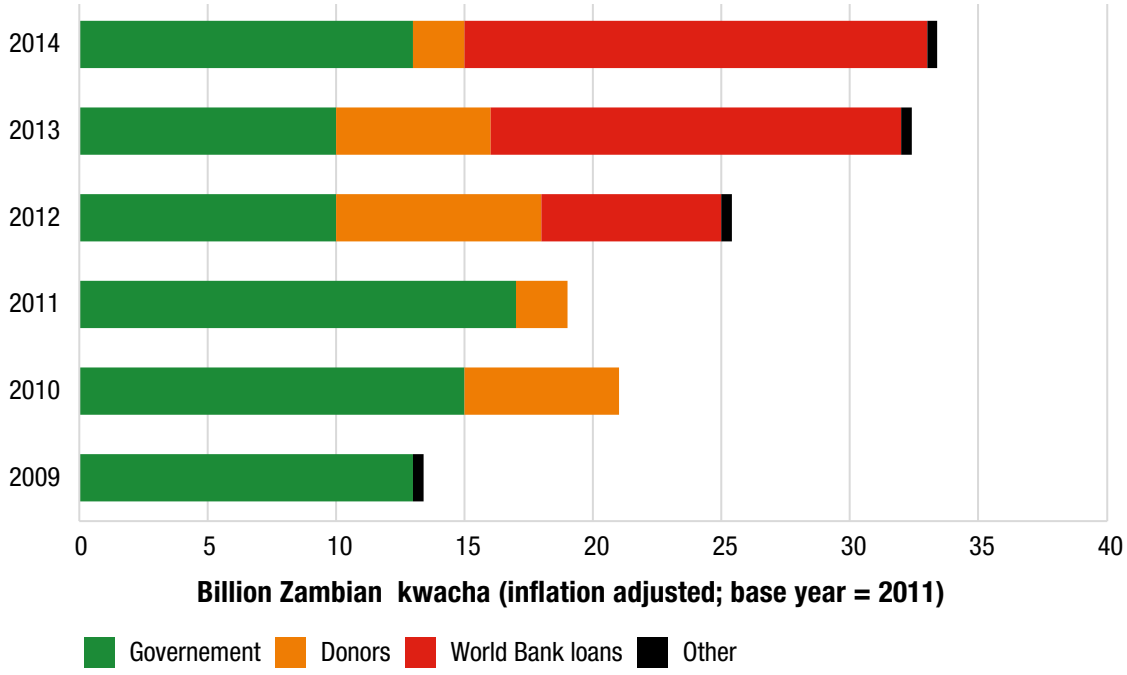
The majority of agriculture researchers work for government research institutes. The Zambia Agriculture Research Institute (ZARI) is the largest agriculture research body, with 144 researchers, almost 60 per cent of all agricultural researchers in the country. ZARI received a $30 million World Bank loan for the period 2012–2019, within the framework of the APPSA, for institutional and human capacity investments in legumes, maize, rice, and sorghum research. ZARI also received funding from several other donor organizations. Agricultural R&D in Zambia focuses mainly on applied crops.

Table 8: Mapping policy areas relevant for supporting STI for food system transformation in Zambia

Policy area	Portfolio lead	Food system intervention area	Relevant objectives for food system	STI related objectives and activities focused on food system
Second National Agriculture Policy (MoA and MoFL, 2016)	Ministry of Agriculture Ministry of Fisheries and Livestock	Production and agricultural R&D; Links along supply and value chain; Consumption (focus on food security rather than health); Environmental impact and adaptation	Vision: An efficient, competitive and sustainable agricultural sector, which assures food and nutrition security, increased employment opportunities and incomes. Objectives are to increase agricultural production and productivity; to increase effectiveness and efficiency of agricultural R&D; to strengthen the capacities of Agricultural Training Institutions; to improve the efficiency of agricultural markets for inputs and outputs; to promote availability of and accessibility to agricultural finance, credit facilities and insurance; to improve food and nutrition security; to promote the sustainable management and use of natural resources; to mainstream environment and climate change in the sector; and to promote the mainstreaming of gender, HIV and AIDS & governance issues in agriculture.	R&D and innovation at the centre of the policy. High-level objective: To increase effectiveness and efficiency of Agricultural Research and Development (R&D), including promoting alternative sources of financing agricultural R&D, promoting PPPs in agricultural R&D, improving capacity to undertake appropriate research incorporating the effects of Climate Change and promoting adaptive research (including research trials). Specific objective to strengthen the research-extension-farmer linkages to improve agricultural production and productivity.
National Industrial Policy (MCTI, 2018)	Ministry of Commerce, Trade and Industry Supported by agencies (IDC) and statutory bodies (e.g. ZDA, PACRA)	Conventional supply chain, including food processing and distribution	Overall objective to transform Zambia from a producer and exporter of primary products into a net exporter of value-added goods utilising local primary resources with increased citizens' participation. Relevant policy focus: Processed foods is one of the eight manufacturing subsectors prioritised in the policy. Agriculture is one of the key supportive sectors in the industrialisation process.	The policy aims to develop strong partnerships promoting domestic innovation through R&D. Key specific objectives for STI: Objective 3: To facilitate the development and implementation of the Industrial Upgrading and Modernisation Programme Specific Objective 5: To promote growth of Cooperatives and Micro Small Medium Enterprises in Industrial development Objective 6: To facilitate the production of high quality Zambian goods. Objectives 7: To promote environmentally sustainable industrial production.
National Social Protection Policy (MCDMCH, 2014)	Ministry of Community Development and Social Welfare	Consumption (food security, nutrition and health)	Objective to enhance food and nutrition security for vulnerable populations and increase livelihood potential among vulnerable populations in order to meet their food and nutrition security requirements year-round.	No explicit objectives related to R&D and innovation. One measure focused on promote climate-smart technologies in order to foster sustainable development to improve livelihoods and empowerment.
National Health Policy (MoH, 2012)	Ministry of Health	Consumption (health); Production (occupational health)	Specific objectives focused on enhancing food safety, nutrition and preventing non-communicable diseases (including unhealthy diets). Improving occupational health (exposure to pesticides in agriculture)	Objective focused on health information and research (but no explicit mention of research on nutrition, diets and food consumption patterns).
Science, Technology and Innovation Policy (MoHE, 2020)	Ministry of Higher Education	Cross-cutting	Responsibility for the overall coordination, monitoring and evaluation of STI programmes including programmes developed and implemented by line ministries (including those focused on food system)	The policy seeks to forge closer links between the programmes of the research and development community and the priority sectors of the economy (including agriculture) Food system relevant projects and activities may be covered under all objectives

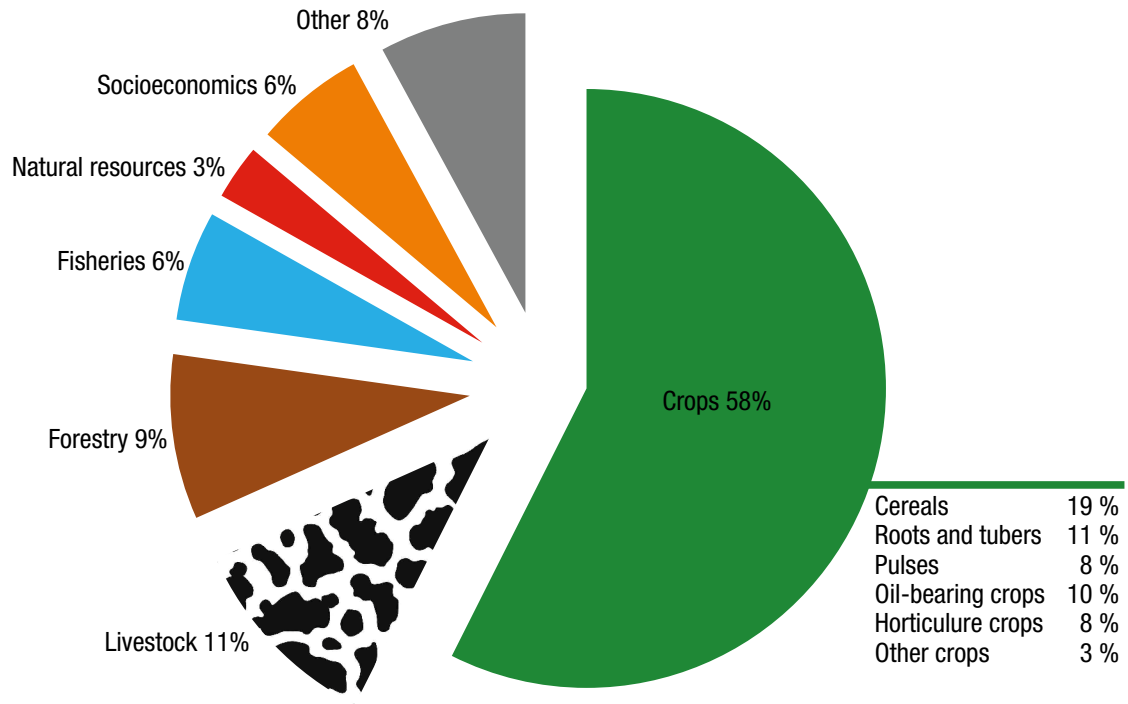
Policy area	Portfolio lead	Food system intervention area	Relevant objectives for food system	STI related objectives and activities focused on food system
National Trade Policy (MCTI, 2018)	Ministry of Commerce, Trade and Industry	Supply chain	Trade promotion and facilitation (including food products) Tariff and non-tariff measures to support trade Export promotion including e.g. developing incentives to attract investments in key sectors and support for local products (campaigns, standards and quality assurance) Promote linkages between SMEs and international markets; IPR protection (supporting R&D and technology transfer)	R&D mentioned as a cross-cutting issue supporting technology development and trade diversification Explicit activity to promote linkages between SMEs and international markets specifically to establish cooperatives in non-primary agricultural sectors
National Financial Sector Development Policy (MoF, 2017)	Ministry of Finance	Production and supply chain	One of key measures is to develop of MSMEs and rural finance (that includes improving access to rural and agriculture finance for MNSMEs)	Objectives to create an enabling environment for innovation (including for technology-enabled financial service delivery models, such as online-based financial services, agent banking, mobile phone–based financial services) and promote an environment that fosters partnerships in research to develop the financial sector
National Energy Policy (MoE, 2019)	Ministry of Energy	Production and supply chains (biofuels)	Increase access to electricity in rural areas Sustainable exploitation of biomass and alternative energy to wood fuel without compromising food security	Objective to promote innovation and R&D in the energy sector and specifically support research and adoption of renewable energy technologies (presumably including biofuels)
National Policy on Climate Change (MNDP and MLNR, 2016)	Ministry of National Development Planning Ministry of Lands & Natural Resources	Environmental impact and adaptation	Importance of the policy for food and water security Objective to promote the adoption of appropriate Climate Smart Agricultural (CSA) technologies for different agro-ecological zones (as a part of adaptation and disaster risk reduction)	R&D as a cross-cutting issue; Objectives to promote the use of prediction models and technologies to determine regional vulnerability of the sectors to climate change, to support higher learning and research institutions on climate related applied research and facilitate R&D and demonstration of new climate-friendly technologies for mitigation and adaptation. Promote dissemination of research findings at all levels.
National Policy on Wetlands (MLNR, 2018)	Ministry of Lands and Natural Resources	Production; Environmental impact and adaptation	Two key objectives to support wetland conservation and protection and their sustainable socio-economic use (including to promote sustainable livelihood options to ensure productivity while protecting wetland resources)	Research explicitly mentioned to support wetland conservation e.g. to promote research, inventorying and monitoring of wetland resources to inform effective management, environmental and socio-economic modelling for wetlands as well as documenting and incorporating indigenous knowledge into decision making Measures to promote the development of green technologies for sustainable use and value addition of wetland resources.
National Water Policy (MEWD, 2010)	Ministry of Water Development, Sanitation, and Environmental Protection	Production, Environmental impact and adaptation	Relevant policy areas: Water for food and agriculture (including developing and managing irrigation projects, promoting water efficiency and collecting and disseminating data); Water for Fisheries; Water supply and sanitation, Water for Environment (sustainable management of water resources and collection of data on water quality and aquatic ecosystems) Strong mandate to monitor, research and assess impacts of projects relevant for sustainable management of water resources	R&D as a cross-cutting issue key for sustainable management of water resources. Research focus areas: extending the traditional fields of water research to include studies in social and financial issues, integrated catchment management, policy analysis and development, decision support systems, capacity building, ecosystem structure and functional development practices; encouraging interdisciplinary and participatory research approaches that provide linkages between technology and communities; reviewing and updating data and information on land-water resources and related socio-economic issues, with particular emphasis on land and water conservation, water use efficiency, user-friendly affordable technologies, and drought-resistant crops; and supporting the standardisation of methods of data collection and processing both at national, regional and international levels.

Figure 13: Funding agricultural research and development in Zambia



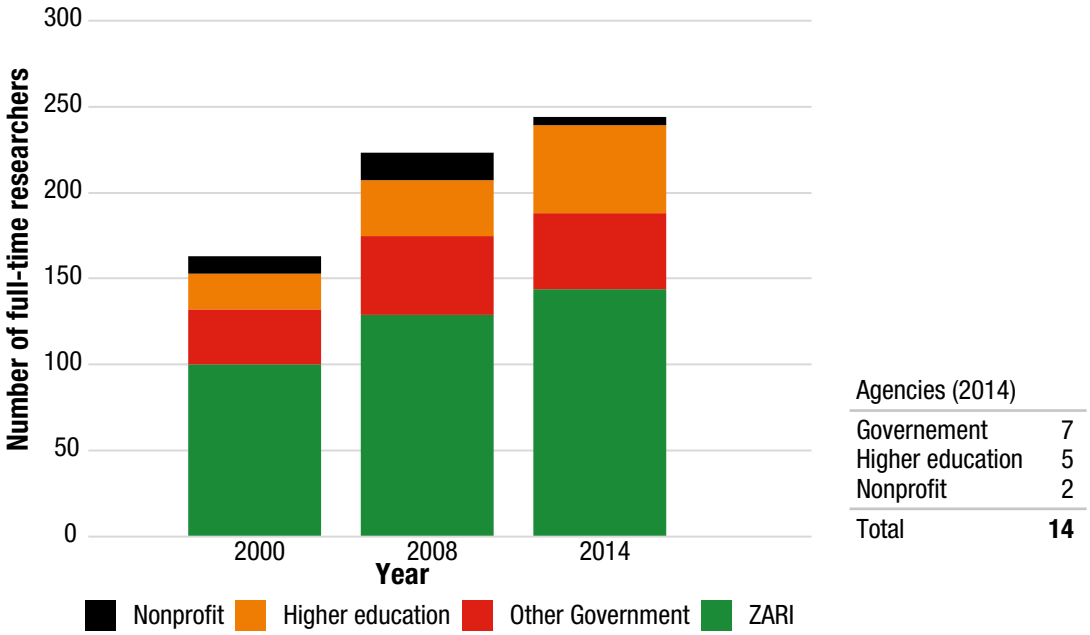
Source: ASTI and ZARI (2017)

Figure 14: Focus on agricultural research in Zambia



Source: ASTI and ZARI, 2017

Figure 15: Agricultural researchers in Zambia



Source: ASTI and ZARI, 2017

The focus on other areas, including socio-economic aspects of agriculture, has been limited (see figure 14). According to the Agricultural Science and Technology Indicators (ASTI) and ZARI, as of 2014 the non-profit organizations conducting agricultural research employed only six full-time researchers (see figure 15).

Two other policies supporting agricultural R&D are the National Policy on Climate Change (MNDP and MLNR, 2016) and the National Policy on Wetlands (MLNR, 2018). Under the adaptation and disaster risk reduction policy priority, the National Policy on Climate Change promotes the adoption of CSA technologies suited to different agro-ecological zones. Both policies have an STI component promoting research, such as climate and socio-economic modelling, and R&D on new climate-friendly technologies.

9.4.3. Food processing and strengthening agro-food value chains

Upgrading the food processing industry and strengthening agro-food value chains is the focus of the National Industrial Policy which has a strong focus on R&D and innovation, including a dedicated objective to promote environmentally sustainable industrial production. Processed foods are one of the eight priority manufacturing subsectors in the policy, while agriculture is one of the key supportive sectors in the industrialization process. Industrial policy has a strong focus on R&D and innovation, including a dedicated objective to promote environmentally sustainable industrial production.

The Industrial Upgrading and Modernization Programme has a broad remit that aims to promote innovation, technological capabilities, R&D and commercialization of innovations, enhance scientific and industrial research, and encourage and enhance the use of ICTs. It also aims to facilitate technology transfer into local industrial production processes, and strengthen the enforcement of intellectual property rights. The policy has a dedicated objective to support MSMEs, and the position of cooperatives and their links with value chains, while supporting start-ups and facilitating access to affordable finance, markets and information. It strives to improve the quality of Zambian products by focusing on standardization and quality assurance.

9.4.4. Environmental aspects of food production

The National Policy on Climate Change, National Water Policy and National Policy on Wetlands all have a strong focus on research including modelling the impact of human activities, such as agriculture, on the environment. Zambian public policy includes several policy areas concerned with environmental aspects of food production, notably the National Policy on Climate Change (MNDP and MLNR, 2016), the National Water Policy (MEWD, 2010) and the National Policy on Wetlands (MLNR,

2018). All these policy areas have a strong focus on research, both to conduct it and to model ecosystems and the impacts of human activity. They also support R&D, environmentally friendly food production technologies, and land management techniques.

The National Policy on Climate Change (MNDP and MLNR, 2016) is a shared portfolio between the Ministry of National Development Planning (MNDP) and the Ministry of Land and Natural Resources (MLNR). The policy focuses on adaptation and mitigation of climate change with direct relevance for food and water security. The policy has an explicit objective to promote CSA techniques. The policy promotes the use of prediction models and technologies to determine regional vulnerability of the sectors to climate change. It provides support to higher learning and research institutions on climate-related applied research, facilitates R&D, and demonstrates new climate-friendly technologies for mitigation and adaptation.

9.4.5. Key challenges for STI policy to foster food system transformation

The Zambian policy mix aimed at the food system is comprehensive but lacks a common outlook on the key challenges and therefore can improve in fostering transformational development. National policies with a potential to transform the Zambian food system cut across several domains. They comprise a number of specific objectives, strategies and concrete instruments focused on food production and processing, food security that ensures better access to food, as well as environmental issues, especially under the label of CSA. The policy mix may appear comprehensive, but it misses an overall vision and strategic framework to foster food system transformation in a coherent way. The challenges discussed below, although relevant for the broad food policy mix, focus on STI policy and governance.

The need for a systemic approach to food systems transformation

Food production and food security are among the top priorities on the policy agenda in Zambia. NDP7 places agricultural diversification and food security among its key objectives. The policy mix, although relatively comprehensive, is not based on a common systemic outlook on a food system, but tackles food challenges predominantly through disconnected individual sub-systems.

This may cause potential for discrepancies (see table 9) as the policy does not systematically address interdependencies between food system elements (e.g., production and nutritional health), or between the food system and other socio-technical systems (e.g., the food-water-energy nexus), or with wider environmental impacts (e.g., deforestation and biodiversity loss).

There are, for example, only limited cross-linkages between objectives focused on productivity and diversification with health- and wellbeing-related goals in the NDP7. Understandably, given persisting challenges of famine and poverty, the current policy places more emphasis on food production and food security rather than on healthy and sustainable consumption. Given the fast-changing diets and growing differences between urban and rural consumption patterns in Zambia, the NDP8 design process will need to pay increasing attention to policies that affect food production and consumption policies, technologies and practices.

This lack of a systemic approach is at the root of many other policy and governance challenges. Future strategic and policy documents, especially the upcoming NDP8, should recognize the systemic nature of food system transformation and include it as one of the key cross-cutting challenges. A systemic approach would help to prioritize STI policy, focusing it on key food system challenges. It would also help to choose innovation pathways with the highest potential to transform Zambia's food system in an economically advantageous, inclusive and environmentally sustainable way.

Table 9: Mapping the relevance of the national policy mix for food system transformation in Zambia

Key actions for food system transformation	1. Reroute farming and rural livelihoods to new trajectories			2. De-risk livelihoods, farms and value chains		3. Reduce emissions through diets and value chains		4. Realign policies, finance, support to social movements, and innovation			
Policy area / Policy	1.1 Ensure zero agricultural land expansion on high-carbon landscape	1.2 Enable markets and public sector actions to incentivize climate-resilient and low emission practices	1.3 Support prosperity through mobility and rural reinvigoration	2.1 Secure resilient livelihoods and value chains through early warning systems and adaptive safety nets	2.2 Help farmers make better choices	3.1 Shift to healthy and sustainable climate-friendly diets	3.2 Reduce food loss and waste	4.1 Implement policy and institutional changes that enable transformation	4.2 Unlock sustainable finance	4.3 Drive social change for more sustainable decisions	4.4 Transform innovation systems to deliver impacts at scale
NDP7											
Second National Agriculture Policy	–0.5	–1 1	1	0.5	–1 1		0.5		–1 1	–1 1 1	
National Industrial Policy		0.5					0.5	1	1		1
National Social Protection Policy		0.5		1	0.5						
National Health Policy										0.5	
Science, Technology and Innovation Policy								1			1
National Trade Policy											
National Financial Sector Development Policy			1						1		
National Energy Policy	–0.5	0.5					–0.5 0.5			–1 1	
National Policy on Climate Change		1		1	1						
National Policy on Wetlands	0.5	1			1		0.5			1	
National Water Policy		0.5		1	1					1	0.5

Source: UNCTAD elaboration based on transformative actions by Steiner ***et al.*** (2020) and the review of policy objectives in the national policy documents of Zambia.

Legend: –1 Strong positive contribution (i.e. strong explicit alignment with policy objectives),
–0.5 Potential positive contribution (i.e. general alignment with policy objectives),
–0.5 Potential risk of negative sustainability impacts (i.e. due to conflicting objectives),
–1 High risk of negative sustainability impacts (i.e. due to explicitly conflicting objective).

Mixed scores are possible when a policy has potentially conflicting objectives.

The need for shared vision and alternative pathways towards a sustainable food system

The policy framework requires an overall coherent vision of what a sustainable food system in Zambia should be and what STI's role should be in fostering the change towards it. There is a need for a broader reflection on alternative transition pathways towards a sustainable food system, considering their economic, social and environmental implications for different social groups and rural communities beyond Lusaka and the Copperbelt.

There is an insufficient reflection on the extent these pathways are compatible and on how to reconcile the economic, social and environmental objectives of various policies while addressing the food-related issues faced by farmers and local communities in different provinces. Zambian policies simultaneously support various technology and innovation pathways to modernize Zambian food production. National policy on climate change (MNDP and MLNR, 2016) prioritizes environmental sustainability and supports CSA and sustainable food production methods. National agricultural policy (MoA and MoFL, 2016), on the other hand, has as its main objective to improve agricultural productivity, mostly by subsidizing the use of chemical fertilizers. However, among its many objectives, agricultural policy also plans to support environmental sustainability and promote CSA methods.

Without careful consideration of alternative technological pathways there is a risk of supporting options that are economically suboptimal (e.g., inefficient use of expensive fertilizers), and contribute to negative environmental impacts (e.g., soil degradation caused by excessive reliance on chemical fertilizers in areas suitable for CSA). Furthermore, the lack of consideration of alternatives is likely to maintain the status-quo and continue to support current unsustainable conventional methods. To foster transformative change, the policy mix needs to be based on a shared vision which clearly spells out its values and priorities and be open to considering alternative transition scenarios which challenge incumbents.

Improving the integration and coordination of STI policy portfolio on food system

As with the wider food policy mix, there are currently no strategic framework and coordination mechanisms to exploit an STI policy portfolio to foster food system transformation. The Zambian policy mix comprises many STI policy strategies and substantive instruments focused on the food system. The design and implementation of these instruments is in the hands of line ministries.

Although MoHE had an overarching role to coordinate STI policy, the current horizontal STI policy does not include mechanisms that allow the identification of key challenges or coordinate policy response in areas where STI could add most value, such as the food system. For example, there are no dedicated governance bodies or coordination mechanisms to take stock of and streamline STI policy instruments addressing food system challenges. The coordination mechanisms established to deal with cross-cutting issues, such as the Cluster Advisory Groups, introduced by NDP7, could be useful for improving overall coordination. They are, however, designed to follow the logic of the NDP which, as mentioned above, did not feature a systemic approach to the food system. In this way, the lack of attention to policy integration focused on the food system reflects the priorities of the current NDP.

Addressing underdeveloped governance of STI for food system transformation

The conducted interviews and reviewed evidence confirm the need to improve inclusivity of STI governance to engage key actors in the process of diagnosis, visioning, policy design, implementation and coordination, as well as monitoring and evaluation, including on the level of specific strategies and programmes. As technology choices in food systems are often uncertain, ethically sensitive, and sometimes contested, it is key to engage stakeholders, including civil society, in the process. There is a need to build linkages and trust among key stakeholders, including farmers, smallholders, businesses along the food value chain, the finance sector, NGOs, research and academia, as well as foreign donors. Trust is key to creating support for policies advocating systemic change, especially when innovations require an overhaul of existing farming and production processes. The governance challenges also include an insufficient collaboration and coordination between similar innovation-oriented initiatives implemented by NGOs and donors.

Strengthening monitoring, evaluation and policy learning capacity

Developing a food systems perspective requires a strong analytical, monitoring and evaluation capacity. There is currently a low capacity across the Government to develop a more systemic approach to collecting and analysing data, including evidence on technologies and innovations which can foster

transformation towards a more sustainable food system. The Government has been made aware of missed opportunities for policy learning by not taking a strategic approach to capacity-building from support received from international development partners in agricultural R&D (World Bank, 2020a). There is a need to invest in the M&E capacity of STI policy in general and specifically in the food system. M&E is necessary for the implementation of projects and programmes as well as at the higher level of overall public policy, as it is the principal source of systematized feedback needed for policy learning.

9.5. Recommendations for STI policy for transforming food system in Zambia

Transforming the food system is a major challenge for policy, requiring a coordinated strategy across the Government. This section focuses on the possible role of STI policy, as a part of a wider food policy mix, in fostering transformation towards a sustainable food system in Zambia. The recommendations depend on strengthening the role and the overall capacity to conduct STI policy in Zambia. The section puts forward six specific recommendations for STI policy for food system:

1. Consolidate a knowledge base on STI for food system transformation;
2. Build multi-stakeholder inclusive STI food system governance;
3. Develop a shared vision and alternative pathways for food system transformation;
4. Formulate a comprehensive STI strategy for food system transformation;
5. Ensure coherence of STI policy mix for food system transformation; and
6. Build evaluation capacity and policy learning for effective implementation.

RECOMMENDATION 1: consolidate a knowledge base on STI for food system transformation.

Develop comprehensive evidence on research and innovation relevant for the food system in Zambia. The purpose of this activity is to consolidate and further develop a knowledge base for the role of STI, notably CSA and other sustainable food production and processing technologies. Such a knowledge base will support STI actors in fostering transformation of the food system across Zambian provinces. This activity will create a better understanding of the existing role of STI and identify concrete research and innovation needs.

Short-term actions

- **Mapping and assessing existing instruments and projects supporting research, technology and innovation in the food system**, deployed by different ministries and donors, that will include assessing their effects in STI across food value chains in different provinces.
- **Mapping government and non-governmental stakeholders** active in STI relevant for the transformation of the Zambian food system.
- **Conducting capacity-building for STI policymakers and stakeholders** (University of Zambia, research institutes, NGOs) to create shared understanding of challenges and opportunities of a sustainable food system, notably CSA, and support collaboration across disciplinary boundaries.

Medium-term actions

- **Establishing an easily accessible and regularly updated platform with up-to-date information on relevant research and innovation activities on the food system** in Zambia, including activities supported by local, national and international programmes.
- **Establishing an integrated research programme on food system transformation** in Zambia based on a collaboration of Zambian knowledge institutions with international partners.

The initial coordination of information collection and sharing could be conducted by MoHE in collaboration with relevant line ministries.

RECOMMENDATION 2: improve coordination on STI policy for the food system.

Zambia has an extensive but uncoordinated policy mix addressing the food system, with many relevant objectives and strategies implemented across national policies. In the absence of any overall strategy dedicated to the food system, the policy mix remains uncoordinated with many activities led by several line ministries, some of which are overlapping or potentially competing.

The established governance mechanisms promoting coordination of cross-cutting issues, including the Cluster Advisory Groups, have not provided a platform

or coordination mechanisms with a dedicated focus on thematic challenges (or socio-technical systems) that cut across strategic areas of NDP7, including on the role of STI in food system transformation. There is an urgent need to develop a policy framework to coordinate various STI instruments deployed to foster food system transformation. The mechanisms should include horizontal (between ministries), vertical (ministries, provinces, districts) and wider governance mechanisms engaging stakeholders.

Cross-ministerial coordination mechanisms are needed to ensure consistency and coherence of an STI policy portfolio addressing the food system. The horizontal 2020 STI policy could provide operational mechanisms to coordinate STI instruments focused on specific high level objectives, challenges or missions. To increase the transformative potential of policy, the wider coordination mechanisms need to engage all key ministries and food system actors in Zambia, including donors investing in projects in food-related topics. This requires more inclusive and flexible mechanisms that encourage building trust and learning.

Short-term actions

- Consider **establishing a cabinet liaison committee for STI for food system transformation** to strengthen inter-ministry collaboration on food.
- Setting up an **inter-ministerial task force for food system transformation** composed of key line ministries and overseen by the liaison committee.
- Develop a multi-agency and multi-stakeholder strategy to **introduce a holistic approach** to the food system in NDP8.

Medium-term actions

- **Create governance mechanisms connecting the liaison committee and the task force with stakeholders and wider STI food governance** in Zambia (see Recommendation 3).

RECOMMENDATION 3: build a multi-stakeholder STI food system governance.

There is a need to strengthen governance of the food system by engaging with stakeholders along value chains, including donors and private financiers, firms and agro-industries, as well as local stakeholders and communities from all provinces. MoHE may step in and take an active facilitation role to connect existing value networks in a wider food system policy community, including reaching out to the wider public and consumers. This is key for building trust, shared ownership and a social mandate for the policy.

Short-term actions

- **Convening multi-stakeholder meetings, including representatives of rural communities and smallholders, to exchange information on the state of the food system**, the role of STI and priorities of STI policy for a food system in Zambia. Outcomes of these meetings should be considered in NDP8.

Medium-term actions

- Establishing a **multi-stakeholder platform for ongoing dialogue and policy learning on the role of STI for food system transformation**. The platform should connect key actors in the agro-food system, including key agencies and external funders. It would benefit from and update the information platform.
- The platform could be convened by the inter-ministerial task force and overseen by a cabinet liaison committee focused on food system transformation.

RECOMMENDATION 4: develop a vision on pathways for food system transformation.

There is a need for a public debate on the future of Zambia's food system, especially on the overall vision of sustainable transition pathways as alternatives to current developments that are unlikely to meet the challenges of the relevant SDGs. The vision and pathways should be situated in the specific national and provincial contexts while considering wider global and regional trends relevant for food systems.

The discussion on alternative transition pathways should consider the advantages and disadvantages of various options for different social groups. They should also consider how to balance investments in tested technologies and techniques with support for developing and testing novel technological and socially innovative solutions. The pathways should be deliberated in an inclusive, participatory way and based on scientific evidence from Zambian and international research.

Short-term actions

- Making use of the multi-stakeholder meetings to discuss and **agree on a shared vision of the food system transformation in Zambia** with a time horizon of 2030. This should align with and elaborate the overall vision in NDP8.

Medium-term actions

- Conducting a participatory **foresight exercise on alternative technology and innovation pathways of food system transformation** in Zambia to compare advantages and disadvantages of different transition pathways in all Zambian provinces. This activity could be conducted by the inter-ministerial task force and overseen by a cabinet liaison committee focused on food system transformation.

RECOMMENDATION 5**: formulate an STI-led strategy to foster food system transformation.**

Develop a comprehensive and horizontal strategy on food system transformation in Zambia to ensure a shared strategic direction and a more coherent approach to the food system across government. STI policy instruments should be at the core of the strategy with a key role in encouraging diversification of supply of healthier and more sustainable foods, with improved resilience to climate change, as well as shaping demand for sustainable and healthy diets. The strategy can provide a roadmap for a gradual deployment of a more comprehensive approach to STI policy instruments.

The strategy should ensure that a portfolio of STI instruments is used to support selected priorities and foster food system transformation. Considering the urgency of food system challenges, innovation investments should prioritize dissemination of existing sustainable technologies and business models. Innovation funding should be available to both technological and non-technological innovations (e.g., business model innovations and social innovation). The policy instruments should be adjusted to the specific economic, social and ecological contexts of Zambian provinces (e.g., capacity development adapted to the local transition needs or fertilizer subsidies adjusted to specific local conditions).

A variety of instruments may be considered to support STI for food system transformation:

- Boost investment in STI relevant for food system:
  - **Increase and streamline public R&D** and innovation investments in sustainable food production and consumption, including from FISP and the Food Reserve Agency. For example, the Government could establish an innovation scheme focused on scaling up CSA in selected provinces using grants from FISP and innovation procurement from the FRA.
- Create market demand for innovative sustainable food products and services:
  - **Use public procurement to create demand** for innovative green technologies and sustainable and healthy products, as well as to promote diversification. For example, FRA could buy a wider basket of staples rather than mainly maize, and gradually implement procurement criteria to favour goods produced on CSA-certified farms.
  - Consider **using fiscal policy instruments to create positive incentives** for sustainable products and technologies, and disincentives for technologies and products proven to have negative environmental and health impacts.
  - Carry out research-based campaigns and manage **educational curricula to increase nutrition literacy designed to promote sustainable and healthy diets**.
- Support local entrepreneurship, business incubation and access to finance:
  - **Invest in business support services and extension services** across the country to strengthen capacity of smallholders and MSMEs to shift to sustainable production (e.g., CSA).
  - Strengthen innovation support and collaboration across food value chains:
  - **Conduct programmes focused on creating sustainable value chains of key crops and food products**, bringing together producers (farmers and cooperatives), business advisory and extension services, processing industry, logistics and retailers.

  - Innovation support should focus on **discovering opportunities in local, regional and international value chains**, rather than assessing the potential of raw inputs and then facing uphill battles in developing products, markets and consumer traction.
- Use regulatory framework to foster sustainable food production and consumption:
  - Regulations are a known driver of environmental innovation. Zambia could consider, for example, **making its environmental legislation more stringent in the areas of waste and industrial pollution to protect its lands, forests and wetlands**, and incentivizing the use of locally-sourced biodegradable inputs where possible and across all sectors and industries.
- Strengthen international STI collaboration on food systems transformation:
  - The Government and stakeholders could actively participate in the **regional and international STI collaborations focused on food systems**, especially in addressing common challenges in the region of the South African Development Community.

Short-term actions

- **Identify and review short- and medium-term opportunities for policy changes** to better utilize STI for transformation, including solutions benefiting smallholders.
- **Formulate STI policy strategy and roadmap** with a proposed timeline of revisions of existing instruments to support food system innovation, notably FISP and FRA.

Medium-term actions

- **Design and start implementing pilot actions** (e.g., the use of FISP to support CSA in one or two provinces). The activity could be led by the cabinet liaison committee with the task force co-chaired by MoHE and MNDP.

RECOMMENDATION 6**: build evaluation and learning capacity for better implementation.**

There is an urgent need for a stronger policy monitoring and evaluation culture across the Government, including in STI policy and food systems STI strategy. The Government and all STI stakeholders would benefit from an introduction of monitoring and evaluation practices within individual STI instruments. They would benefit also from developing the capacity to consolidate and reflect on evidence gathered from across many policy instruments and projects focused on food system transformation in a virtuous upward spiral of policy learning.

Short-term actions

- **Conduct an external evaluation of the Government's instruments supporting STI in food systems**.
- **Assess specific needs in terms of monitoring and evaluation of STI policy**.

Medium-term actions

- **Invest in evaluation capacity** with a focus on STI policy concerning food systems.
- Build and nurture communities of practitioners and **engage stakeholders and experts to critically reflect available evidence on STI policy**. The debates should address challenging topics, such as the position of smallholders versus international companies, social-ecological risks, and the costs of various technology options.
- The activity could be led by MoHE and MNDP and implemented by the task force.

10. Mining sector challenges and STI

10.1. Introduction

Mining in Zambia contributes to about 10 per cent of value added to GDP and constitutes about one-third of national industrial activity. Zambia needs to ensure that mining benefits the nation and all its citizens. However, Zambia does not have a national policy for the mining sector and therefore policy choices are not expressed and linkages with other policy areas, such as STI, cannot be made in a formal and systematic way. Copper is the main mining product and this section mostly discusses the copper mining sector. The Zambian economy is fundamentally dependent on copper mining for tax revenue as well as hard currency export earnings.

Zambia produced 882,000 tons of copper in 2020, up from 796,000 tons produced in 2019, which represents about 5 per cent of global production.

Zambia aims to produce more than 900,000 tons of copper in 2021, and plans to exceed one million tons in the near future. The copper mining sector accounts for more than 70 per cent of national exports (see table 10).[97, 98]

Mining contributes to about 28 per cent of government revenue collection, mostly as mining royalties (see table 10 and figures 16 and 17). The mining sector directly employs about 2.4 per cent of the total population employed in Zambia and contributes indirectly to between 50 per cent and 70 per cent of GDP in various supporting sectors and services.[99] At the same time, the growth of the mining sector has resulted in increased volumes of waste generated, such as waste rock, tailings and slug dumps for which new land has been opened up for disposal (ZEMA, 2017).[100]

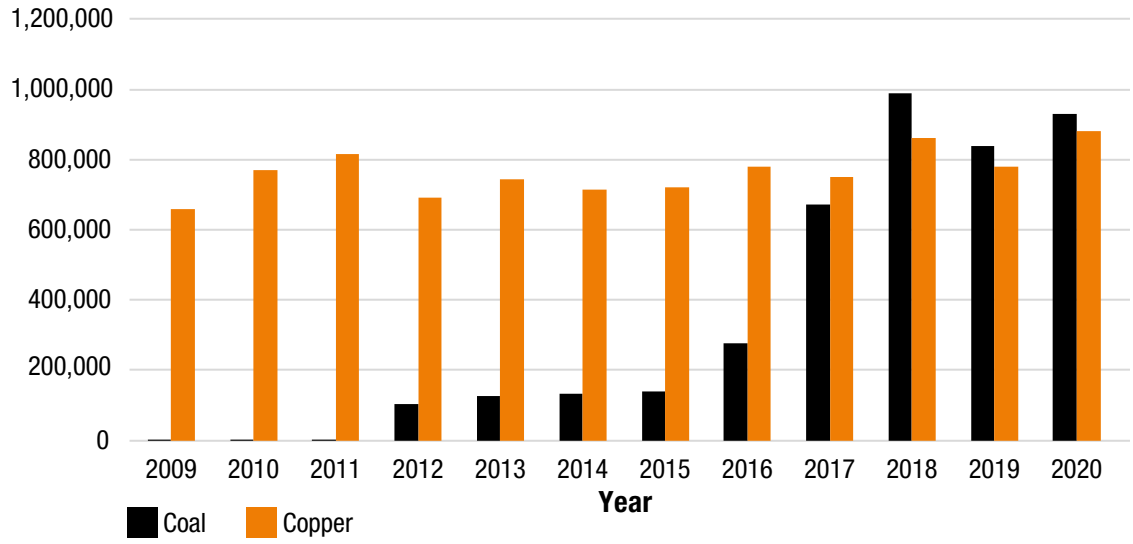
The Mining and Minerals Development Act that provides a regulatory framework for the sector, but it is not equivalent to a national policy. The Act falls short on strategic perspectives and providing a framework for policy that could resemble an innovation system approach with clear and measurable objectives, and identified stakeholders, collaborations and linkages.

Table 10: Contribution of Mining to Zambia's Economy

	2019	2018	Change
GDP	9.90%	10.70%	-7.48%
Exports	77.00%	78.40%	-1.79%
Revenues	27.77%	31.40%	-11.57%
Employment	2.40%	2.90%	-17.24%

Source: ZEC, 2020

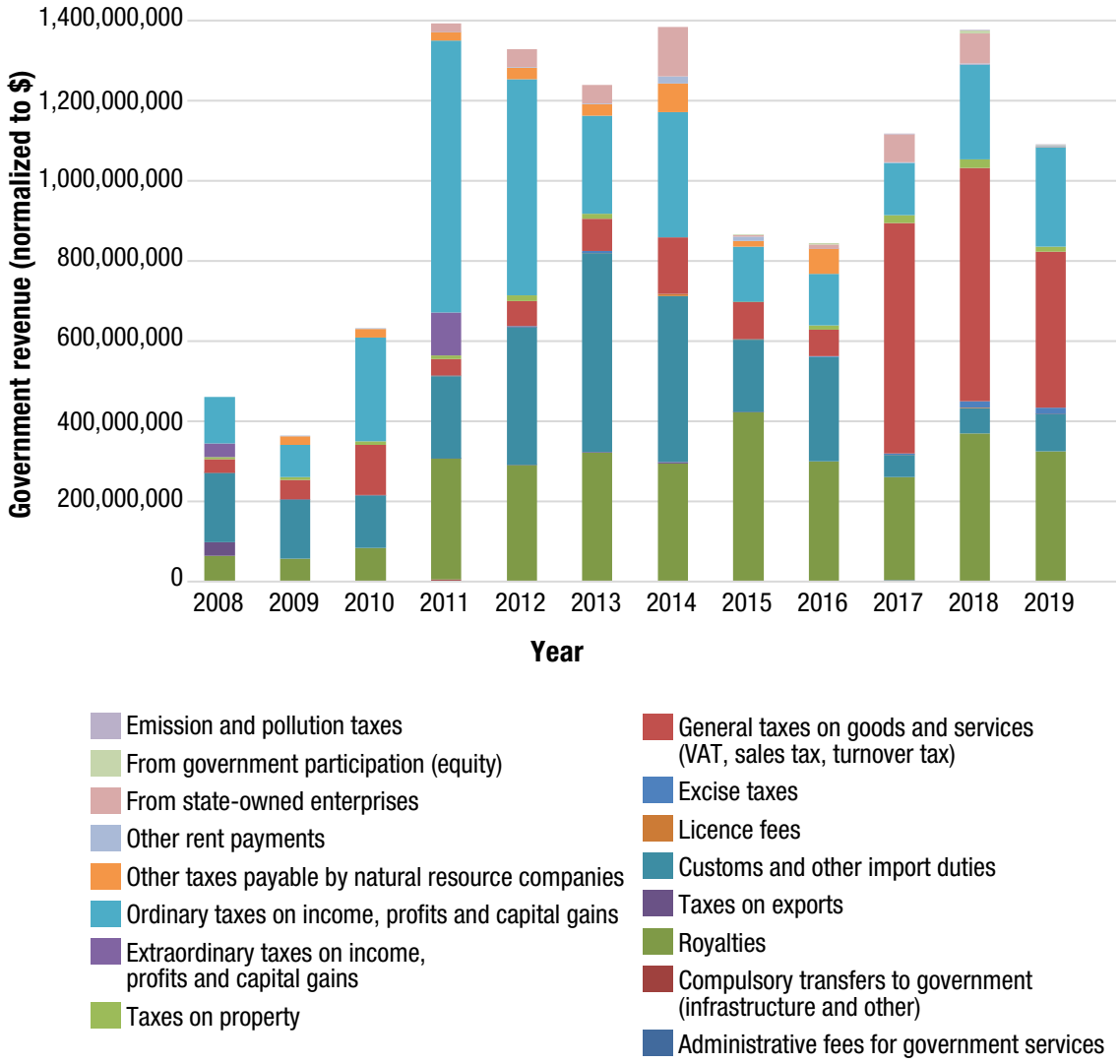
Figure 16: Mineral Production (tons) in Zambia



Source: Extractive Industries Transparency Initiative; www.iea.org/countries/zambia

The high level of economic and social importance of the mining sector means that STI policy must engage with the sector and deepen collaboration. STI policy engagement is vital, both from growth, technology and economic development perspectives, as well as from an SDG perspective, highlighting the challenges of inclusiveness and environmental protection.

Figure 17: Contribution of mining to government revenues



Source: Extractive Industries Transparency Initiative

Mining is an extensive user of technology and a destination for FDI. The optimistic assumption, therefore, is that there is much to be gained in open and transparent collaboration between STI stakeholders and the mining industry. The current trend in the steady rise of copper prices as the world accelerates towards an ever-increasing use of electricity, including in transport and mobility, should be a positive contributing factor, despite difficulties brought about by the COVID-19 pandemic.

A mining policy that works for the SDGs needs willingness to collaborate among diverse stakeholders. This requires improving relationships and increasing trust among stakeholders, in particular between government and industry. However, the level of trust between the Government and mining sector firms and investors is far from ideal. Given mutual perceptions and the difficult relationships that they underscore, it will be a major policy effort to move into a policy space defined by collaboration, cooperation and a sense of common destiny.

Given that a systems approach to STI relies on strong collaboration among stakeholders through the development of linkages and interactions, the strained relationships between public and private interests in the mining sector are a disadvantage. As discussed in part I of this review, given the state of relationships, it is not surprising that attempts to use the mining industry to technologically upgrade proximate sectors, and diversify out of a detrimental dependency on copper exports, have not met with much success. Such outcomes, which are neither acceptable to the Government nor the country's citizens, require a rethink of policies managing the role and contribution of copper mining to the economy and society.

10.2. Policy landscape and governance of mining in Zambia

10.2.1. Mining, NDP7 and NDP8

NDP7 treats mining as an opportunity for diversification and export growth but does not connect this challenge with the STI domain. While NDP7 clearly recognizes seriousness of the mining dependency issue, it does not connect this policy task to the STI domain or recognize the overwhelming equivalence between diversification as a macro-economic phenomenon and innovation – its firm-level manifestation. The proposed diversification strategy – broadening the range of minerals – is unambitious and does not engage in transformative change resulting from the application of new or novel technologies, traditional engineering or ICTs.

The key task for NDP8 should be setting the stage for the development of a national mining strategy, with a commensurate focus on the copper mining and smelting sub-sector. Without an explicit policy vision for the sector, establishing linkages and collaborations becomes problematic, rendering it an unstructured endeavour – difficult to evaluate and with reduced impact on policy learning. Links between the Ministry of Mines and Mineral Development (MMMD), ZCCM-IH, ZEMA, agencies and stakeholders with strong STI policy concerns are left to be defined on-the-go. While the Mines and Minerals Development Act (2015) spells out the basic policy concerns, it largely deals with regulations and legal requirements for operators in the mining sector.

10.2.2. Regulations and policies in mining

While its principles can be considered as the core of a mining policy, the Mines and Minerals Development Act (MMDA) is not a policy and Zambia does not have a specific policy for the mining sector. [101] The MMDA is a revision of the law relating to the exploration, mining and processing of minerals. Other relevant policies include the tax regime for the mining sector, the Citizen Economic Empowerment Act (2006), the Mineral Resources Development Policy (2013), and the National Industrial Policy 2018.[102] A principle of the MMDA is that mining of mineral resources shall be explored and developed in a manner that promotes and contributes to socio-economic development, while ensuring safety, health and environmental protection. Other principles are cited in box 12. The principles can be considered as the core of a mining policy. However, the MMDA is not a policy and Zambia does not have a specific policy for the mining sector.

Box 12: General principles for mining and minerals development, MMDA 2015 Part I, item 4

The following principles shall apply to the mining and development of minerals:

a) mineral resources are a non-renewable resource and shall be conserved, developed and used prudently, taking into account the needs of present and future generations;
b) mineral resources shall be explored and developed in a manner that promotes and contributes to socio-economic development and in accordance with international conventions to which Zambia is a party;
c) the exploitation of minerals shall ensure safety, health and environmental protection;
d) wasteful mining practices shall be avoided so as to promote sustainable development and prevent adverse environmental effects;
e) citizens shall have equitable access to mineral resources and benefit from mineral resources development; and
f) development of local communities in areas surrounding the mining area shall be based on prioritization of community needs, health and safety.

A well-designed policy can provide a consensus on the challenges for the sector, as well as a strategic and realistic view on its development and contribution to Zambian society, including STI aspects. It can also explicitly describe who are the frontline mining and STI-in-mining stakeholders, their capabilities, what support they may need and what is expected as their contribution.

A policy supporting the development of effective linkages among mining sector stakeholders, including domestic suppliers, and with stakeholders in the broader Zambian innovation system, is a critical but long-term policy target.

Existing regulations have neither led to a greater involvement of Zambian-owned businesses in mining operations, beyond the provision of energy and some services, nor to a growth of technologically proximate firms and industries. The result is that up to 95 per cent of goods and services procured by the mining industry are imported (World Bank, 2016).

Beyond long-term path dependencies or a short-term lack of demand, one possible reason that the mining sector is not more involved with the rest of the economy is the lack of a sector policy beyond regulations that focus on legal categories and ensuring tax revenue collection (see box 13). Should Zambia develop a stronger policy perspective on mining, there may be various routes to address this problem. One is to diversify away from the mining sector altogether, as proposed in NDP7. As indicated in part I, this requires strong support for promoting STI-led growth in the ICT sector and in agriculture, or as better described in chapter 9 of this review, in the food system. A second option is to diversify through the development of proximate and upstream sectors from copper mining and smelting, also supported by NDP7.

These routes are not mutually exclusive. The common element is the need for horizontal cooperation across policy domains. However, if mining interests insist and succeed at keeping perceived government involvement to a minimum, without a vision expressed as a national mining policy, and largely limited to collecting royalties, STI policy and other polices with strong STI components (industry, agriculture, ICT, health, energy, etc.) will not have a policy peer in the mining sector to collaborate with.

Box 13: Regulation on tax revenue from mining

The Zambia Revenue Authority (ZRA) taxes mining operations in Zambia through corporate tax and through a separate and additional mineral royalty.

Under the Income Tax Act, the corporate income tax rate applicable to companies carrying out mining operations is 30 per cent. There is a limitation on the deduction of losses to 50 per cent of taxable income.

Mineral royalties amount to 5 per cent on base metals (except copper), energy and industrial minerals, and 6 per cent for gemstones and precious metals. For copper, the mineral royalty rate is 4 per cent when the price of copper is less than $4,500 per ton. It rises to 5 per cent where the price of copper is more than $4,500 but less than $6,000 per ton. The rate peaks at 6 per cent when copper prices exceed $6,000 per ton.[103] Prices are considered as the monthly average London Metal Exchange cash price per ton. Mineral royalties are not deductible from income tax.

Following years of dissatisfaction with corporate tax as a revenue tool, there is a shift to increase reliance on mineral royalties. Mineral royalties are much easier to assess and collect compared to an income-profit-based tax system. The later requires larger numbers of highly qualified tax experts working for revenue authorities, as well as a mining sector that plays fair in terms of income base erosion, profit shifting and transfer pricing (Siwale T and Chibuye B, 2019). In a recent example from 2020, the MMMD indicated that some miners are suspected of undervaluing their production to pay less taxes. They were reported to have submitted low-grade samples to the state laboratory, causing an undervaluation of mineral exports and depriving the Government of mineral royalty tax revenue.[104]

The key objective of a national mining policy would be to better integrate its objectives into the overall national development agenda. This would enable interaction with other policy domains at the highest level, including with STI policy, and energize transformative change. Any future policy on the mining sector will need to have a strong STI component. It is entirely conceivable that Zambia, as a global player in copper mining, can develop a high level of technological and engineering expertise that may be demanded and deployed continent-wide.

Focusing on innovation and with strong collaboration of partnering ministries, a national mining policy would be able to designate the fundamental elements supporting the growth of indigenous firms in the mining sector. Infrastructure planning and public-private partnerships for transport and logistics development could also be important elements.

On sustainable and inclusive development, a future policy would require closer collaboration between the MMMD, ZEMA, MoHE and MCTI

and would necessarily include the development of a broader stakeholder group with prominent STI- and SDG-related development goals. The group would review social and environmental impact and assessment studies, advise on STI options and possibilities, and develop and promote enabling linkages and collaborations (World Bank, 2016). Transformational impact would require a focus on using innovation to target the SDGs and address economic, social and environmental challenges in a comprehensive manner.

10.2.3. Governance, the mining sector and transformation

Governance involves ensuring accountability, supporting corporate social responsibility, ensuring timely and complete payment of taxes, curbing illicit financial flows and transfer pricing, enabling technological upgrading and improvements in productivity and revenues through innovation, and environmental responsibility. Other dimensions of governance include issues that relate to fairness of labour practices and employment of local staff, contracts, ethics and adequate, "… compliance to standards stipulated in national and international mining codes" (Mbilima, 2019). The governance of mining primarily relates to the MMMD, ZEMA and ZRA. A broader range of stakeholders would include MoHE, the MCTI, the Chamber of Mines (ZCM), CSOs and NGOs, as well as development partners and international organizations active in Zambia (Mbilima, 2019; Sánchez and Hartlieb, 2020).

In governing STI policy to contribute to energizing transformation in the mining sector, policymakers should note the following challenges and opportunities:

- **Exploring innovation in policymaking** by conducting policy formulation, implementation and evaluation that is based on effective public- and private-sector and civil society stakeholder engagements and participation, informed by appropriate innovation systems and SDG frameworks, and underpinned by robust evidence and risk assessment.
- **Supporting collaborations and partnerships** that foster co-creation, co-learning, and policy experimentation. Experimentation is essential to uncovering new approaches to policy design and implementation, and governance arrangements that are more likely to produce improvements in results and greater policy impacts.
- **Improving the understanding of the factors that hinder, influence and shape resource allocations and funding through consideration of the political economy**. These factors are particularly prominent in the mining sector as they relate to gender equality, and the development of human capabilities and skills in related engineering disciplines (Mbilima, 2019; Daniels *et al.*, 2020).
- **Developing coherence among relevant policies, legislations, frameworks and sectors, and improved coordination and cooperation**. This will become important should Zambia embark on developing a strategic and STI-led national policy for the mining sector.
- **Developing policy themes for future national development plans that embrace the strong relationship between the mining industry and its underlying technological and engineering foundations**. Based on this perception, extrapolate the scope of directly involved stakeholders to include institutions with capacities and ambitions to engage with the mining sector in R&D, training and human capacity development.

10.3. Challenges and opportunities for the mining sector

The recent impacts from the COVID-19 pandemic have weakened Zambia's capacity to respond to many of the country's pressing challenges. Despite the socio-economic challenges that preceded the COVID-19 pandemic, Zambia recorded increasing FDI between 2014 and 2019, becoming one of the highest recipients of FDIs in the Southern African region (UNCTAD, 2020). Unserviceably high levels of external debt were amassed in 2020 and Zambia was one of the first countries in Africa to default on her external debt during the pandemic. [105] To this end, a significant proportion of the Government's revenue is spent on debt servicing, which limits fiscal space and its ability to commit funds to STI or social and environmental targets articulated in the SDGs (World Bank, 2019, 2020a).

10.3.1. Low productivity and environmental costs

A decrease in physical productivity in the copper mining together with an ever-increasing awareness of the environmental and social impacts of mining has highlighted the need to invest in STI. An important challenge for copper and the mining sector is the need to improve productivity. Productivity in extractive industries is often seen against the backdrop of global markets, and copper has fluctuated wildly during the past two decades. A decrease in physical productivity in the sector has been attributed to factors such as decreasing ore grades and the need for mining operations to be handled at deeper deposits. Further challenges arise from harder rock mass. An ever-increasing awareness of the environmental and social impacts of mining (Sánchez and Hartlieb, 2020) has highlighted the need to invest in environmental protection and switch to using environmentally sound technologies and practices, as well as engaging an able judiciary to pursue the interests of its citizens.

A recent example is the water pollution that has resulted from toxic run-off from the KCM Nchanga mine, which has been in operation since 2004. Toxins in the contaminated water table were reported to have been affecting crops, livestock and the vegetation surrounding the river, and destroying the health and livelihoods of local people who depend on farming and fishing to support their families. Women and children were most affected as they need to make 10km round trips on foot in search of clean water, while older and disabled people, unable to walk so far, fell ill from drinking the polluted water.[106] In January 2021, KCM agreed to settle all claims brought against it by more than 2,500 local inhabitants.[107]

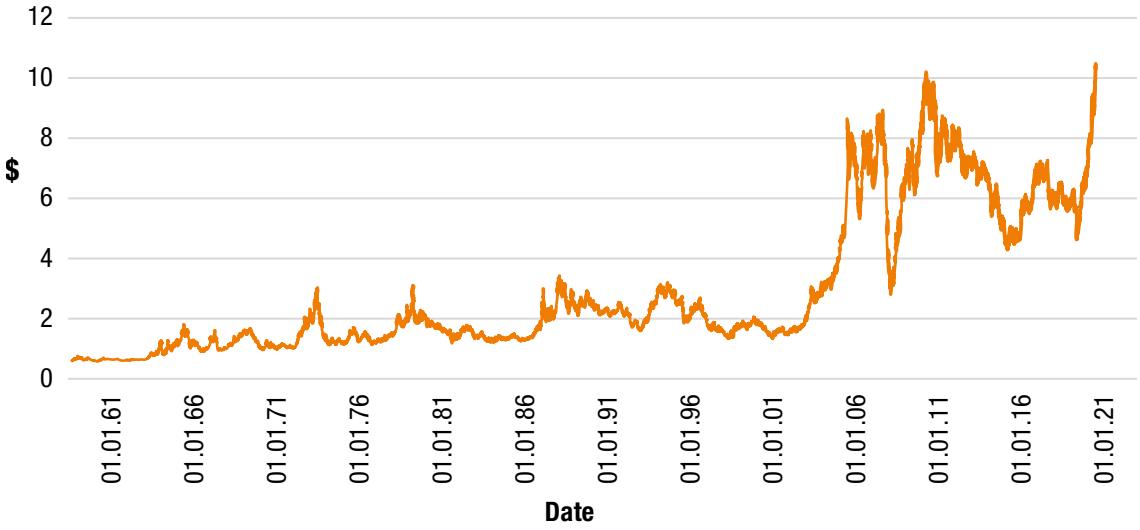
Air pollution is also an impactful consequence of mining. Its effects are reported to be visible on the local vegetation. For example, the Kankoyo Township in Mufulira, in the Copperbelt, has suffered severely and has been declared a wasteland (Mwaanga *et al.*, 2019). Respiratory complications associated with air pollution are reported to be on the increase. Objective and factual surveys of the adverse impacts of mining air pollution, as well as other pollution and degradation on human health and the economic costs, are needed to make the correct policy decisions. Developing a factual base for policy will necessarily be an interdisciplinary effort as it must bring together experts from health and medical science, biology and geology, as well as social sciences. This is because recommendations for mitigation or adaption must move beyond technological recommendation and deliver solutions that are realistic as functional elements in a society.

Internalizing externalities that negatively impact SDGs will need to become a Zambian priority as much as they are a global one. The mining industry is sensitive to costs and unless all countries act in a synchronized manner in raising and enforcing environmental, labour and safety standards, investors will consider assessing feasibility and shutting insufficiently profitable operations, while opting to move investment to less regulated countries.

10.3.2. Copper price volatility

While volatile, since 2019, global copper prices have grown steeply following optimism about developments in renewable and green sources of electricity and the impending switch to electrical power in transport and mobility. Fluctuating copper prices have posed challenges for the Zambian mining and extractive sector and indeed for the entire economy. As figure 18 shows, the price of copper started rising after ,000 on the back of the development of ICTs and the technological transformation of Asian economies, including China. This trend ended abruptly in 2008 as the subprime crisis shocked the global economy into recession. However, prices quickly recovered and hit new highs in early 2011. Since then, prices have been volatile, fluctuating between $4 and $7 per kg. The dips in copper prices and near collapse in 2015/2016 resulted in severe economic shocks to Zambia's economy. Since 2019, prices have grown steeply following optimism about developments in renewable and green sources of electricity and the impending switch to electrical power in transport and mobility.

Figure 18: LME Copper Historical Price Grace



Source: www.macrotrends.net, LME[108]

Various factor have been advanced for the inability of Zambia to effectively reap the full rewards of her natural resources. They include transfer pricing and accounting practices by multinational corporations who are large investors in minerals and the extractive sector and who control copper exports produced by Zambia's mines and smelters. Other factors relate to the tight fiscal space resulting from the external debt, which limits the ZCCM-IH's capacity to purchase additional shares in Zambia's mines and smelters. Finally, the inability to fully harness digital transformation in the mining and extractive sector is an important challenge (Sequeira *et al.*, 2016; World Bank, 2019; Sánchez and Hartlieb, 2020; World Bank, 2020b/c). These factors hinder the development of technological capabilities of local firms and their ability to evolve proximate activities with or without using copper as an input.

10.3.3. Knowledge, capacity-building and the SDGs

Broad based action is needed to strengthen Zambia's capacity to benefit from the mining sector and, at the same time, address the SDGs. This would include skills and competencies n knowledge management, vocational training and technical and legal capacity to govern beneficial ownership. Zambia's capacity-building needs, specific to the mining sector and at the level of policy, should be contextualized against the concept of beneficial ownership, while addressing SDGs which are strongly linked to the STI policy domain.[109] Capacity-building may be needed to tackle the following challenges[110].

- **Enhanced knowledge management** competency is needed to coordinate and govern diverse policies, regulations and the socio-technical system of innovation in the mining sector.
- **Strengthened capacity of vocational training, tertiary engineering education and R&D** to engage with technological problems and innovation challenges in the mining sector, including in developing proximate value adding activities in collaboration with international and national firms and entrepreneurs.
- **Improved legal technical capacity in the Government** to better govern beneficial ownership agreements, including for the establishment and maintenance of beneficial ownership registers, verification mechanisms, and communication with mining companies – the actual beneficial owners. Government may also improve competencies in technical skills on undertaking analysis of beneficial ownership and related data.
- Established capacity and initiative at the **MMMD to engage with diverse bodies and agencies**, including the ZRA, MoHE, MCTI, MWDSEP, MLNR, MoE, MoH and others active in the agriculture sector and with linkages to rural communities.
- **Established capacity and horizontal coordination mechanisms** to share experiences on beneficial ownership and management of transfer pricing issues with other countries, development partners and international organizations.

- **Capacity-building is needed among managers and executives of mining companies to ensure familiarity with beneficial ownership** reporting, guidance on identifying, collecting and disclosing initial beneficial ownership information, as well as procedures and systems for updating and submitting data to government authorities.
- **Capacity-building on corporate transparency and corporate social responsibility** is needed for all investors in the sector.
- **Capacity-building for civil society could focus on public monitoring of beneficial ownership data** and changes over time, how to use beneficial ownership information in advocacy and campaigns (and coordination of objectives/advocacy efforts), on networking and coordination (within the civil society network and with other constituencies), and negotiation skills.

ZCM could serve as a forum for company capacity-building and assist with outreach efforts. An example of recent collaboration between ZCM and the vocational training agency TEVETA is presented in box 14. ZCM and ZCCM-IH could closely work with Zambia EITI to develop company-specific beneficial ownership roadmaps. The Beneficial Ownership Roadmap has positive implications for SDG targets as it focuses on citizens and improvements in social welfare. It is also a way forward through a collaborative setting and may contribute to easing traditional tensions between investors and government. ZCM could also produce a guidance note on ownership structures in Zambia, which will help inform collection of data and data research. Support from development partners and international organizations would be forthcoming for well-structured requests.

Box 14: TEVETA, ZCM and MCTC train miners for rescue safety

The mining industry presents unique challenges to safety. A combination of safety practices and skills are highly demanded for the improved protection of miners, mining infrastructure and equipment. One particular competency – mine rescuer training – has until now required training abroad. The high cost of such training translated into inadequate numbers of rescuers.

To address mine rescue skills shortages in the country, TEVETA, the ZCM and Mopani Central Training Centre have signed a tripartite training agreement to train miners in mine rescue skills, including for the largest mines run by KCM and First Quantum. This partnership demonstrates the advantages of industry-education collaboration. The training is financed through the Skills Development Fund. The facilities are provided by the Mopani Central Training Centre.

Beyond improving safety conditions, skilled rescuers raise Zambia's profile as a competitive mining investment destination. Skilled human resource is a vital component in attracting investment. The training also promotes closer collaboration between industry and national training providers. For employees, the training works against skill obsolescence and secures job prospects. Through this collaboration, TEVETA itself gains exposure to new technologies and production systems.

Source: ZCM[111]

10.4. Transforming mining in Zambia

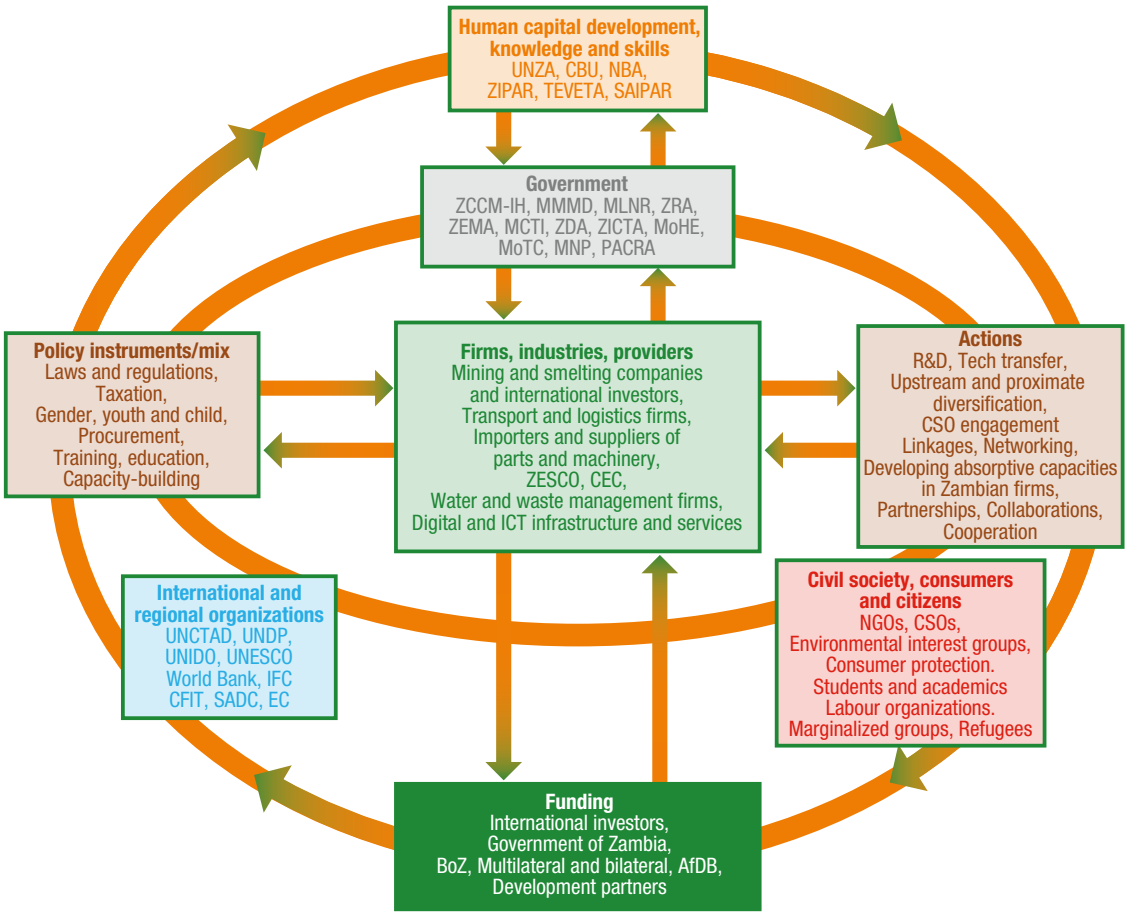
Transforming mining in Zambia requires two determined actions: one is supporting innovation in the sector while the second is enabling knowledge and technology flows. There are two long-term challenges for Zambian policymakers. The first is, how to support innovation in the mining sector when viewed more broadly than just the mining and smelting companies. The second is, how to enable knowledge and technology flows, including soft technologies, from mining companies to Zambian firms that collaborate with miners, or who have a potential interest, if they can technologically upgrade themselves. The assumption is that international mining companies and investors have a high level of technological and managerial knowledge and competency, and Zambian firms may benefit by collaborating with them.

Technology and innovation play a critical role in the mining industry. The range is broad, from improving the efficiency of mining processes, to reducing costs across the value chain, to addressing social and environmental concerns among stakeholders and rural communities. Technological progress is also vital for the exploitation of new copper deposits in more complex scenarios (Sánchez and Hartlieb, 2020).

10.4.1. An innovation system approach

Enabling the mining sector with a well formulated and STI-led strategic policy will allow for a more structured interaction with other policy domains. Operationalizing a functional innovation ecosystem in the mining sector – one that helps ensure that STI is appropriately harnessed for achieving the challenges addressed in this report – requires effective interaction, coordination and governance of the actors and stakeholders. To this end, energizing innovation for development requires open discussions on the roles, responsibilities and capabilities of diverse STI stakeholders. Figure 19 proposes a representation of the actors and stakeholders that constitute the mining sector system of innovation in Zambia.

Figure 19: System of innovation for Mining in Zambia: key actors and stakeholders



The shift away from natural resource dependencies towards a diversified economy requires greater emphasis on active multi-stakeholder engagement and collaboration, led by a clearly stated strategic policy (World Bank, 2019; MNDP, 2017). To achieve this goal requires an innovation systems approach, which takes a challenge-led multi-stakeholder view of the mining sector and its linkages to other socio-economic activities and consequences. Deepening the understanding of interactions with other policy domains is necessary for arriving at mutually re-enforcing cross-cutting policy interventions. This approach is supported by NDP7, which makes a shift to integrated development based on multi-sector planning.

The immediate aim of policies and regulations on mining should be to enable the mining sector's contribution to Zambian socio-economic and sustainable development. Predictability and stability of policy will strengthen the business climate, incentivize FDI, and operationalize regulations that foster good governance of environmental and natural resources. While the mining sector must work

for the benefit of Zambia's citizens, government engagement with the mining sector should be based on mutual understanding, collaboration, goodwill and the development of win-win scenarios that are in turn based on clear and explicit long-term policy perspectives. Developing the full potential of natural resources requires exploring links between mining and other sectors. To this end, any future policy will need to focus on opportunities for transformative change.

Field interviews during UNCTAD's mission revealed that greater Zambian involvement in the mining sector was desirable, beyond its role as tax collector. There were many specific challenges and opportunities noted during discussions, some of which are listed below.

- The importance of capacity-building in mining engineering, technology and management, with a view to improving national capabilities to own and operate mines as principals and with eventual international technology partners, in the near- to medium-term.
- The need to develop an explicit and strategic mining policy that goes beyond regulatory tools and tax laws, to provide a framework for a technological roadmap and foster the necessary linkages, especially among Zambian ecosystem actors, especially academia and upstream and proximate industry.
- The need to develop an explicit and strategic mining policy that outlines the roles and responsibilities of innovation and digital ecosystems actors and stakeholders with reference to their cooperation with mines, smelters and other value chain actors.
- The importance of improvements in partnerships between the mining sector and academia in education as well as in joint R&D.
- The provision of adequate infrastructure and modernization of transport and logistics infrastructure, enhanced with digital technologies. These elements are key to having an internationally competitive mining sector.
- The need for greater attention to the vital role that M/SMEs play in the natural resources and mining sector. This is vital to job creation and inclusive economic development.

As the figure 19 shows, explicit links can be drawn between Zambia's diverse stakeholders and institutions. They are joined by arrows symbolizing potential relationships, collaborations, knowledge and technology flows and transfers. These are enabled through the policy mix, a set of policy actions and tools, and funding mechanisms. Central to the system are the firms and industries where knowledge and technology is practically implemented in production and where innovation materializes. The mining innovation system is related to other systems, such as education, agriculture, the digital economy and ICTs.

For example, the links between mining, agriculture and food systems, and related areas such as biodiversity and environment cannot be overemphasized. Pollution and habitat destruction are an imported issue that are compounded by climate change and the use of low-quality fuels for energy in rural society. More directly, an insufficient productivity growth and structural transformation in agriculture is related to a lack of investment in technological upgrading supported through public funding from tax revenues collected, among others, from the mining sector.

The mining sector can also have positive technological impacts on related sectors, such as transport, energy, construction materials, and engineering. However, these will be difficult to materialize based on random or sporadic interactions or initiatives. Enabling the mining sector with a well formulated and STI-led strategic policy will allow for a more structured interaction with other policy domains. This is provided a systems of innovation framework is embraced in policy, and policy objectives challenge stakeholders to be innovative contributors to Zambia's socio-economic transformation and sustainable development.

10.4.2. Digital transformation

Zambia has a vibrant digital ecosystem ready to interact with the mining sector and contribute to its digital transformation. The ZCCM-IH, with its broad shareholding in almost all mining operations in Zambia, is ideally positioned to bring together interested public and private sector STI stakeholders. Accelerating progress in digital innovation and technology can help support the digitalization of the mining sector. However, the discussions of the role and opportunities availed by digital technologies in the mining sector are more about potential rather than practice. In a recent study (Barnewold and Lottermoser, 2020) the main potential technologies leading digital transformation would be automation, big data, Internet of Things, robotics and real-time data processing. In terms of operations,

digital transformation will need to improve asset performance and reduce risk. This will require better integration between mining, processing and transport functions, i.e., across the entire mining supply and value chain. Success will depend on the availability of trained staff and successful collaborations in R&D with specialized firms and institutes.

Harnessing digital innovation in mining requires a deeper understanding of the system within which the relevant actors and stakeholders operate. Zambia has a vibrant digital ecosystem ready to interact with the mining sector and contribute to its digital transformation. These actors include public agencies and private sector firms and digital entrepreneurs. Digital transformation in mining will require collaborations among agencies and industries to spur integration of digital technology in mining. The ZCCM-IH, with its broad shareholding in almost all mining operations in Zambia, is ideally positioned to bring together interested public and private sector STI stakeholders to explore the potential and develop an assessment of the opportunities of digital transformation in the mining sector, such that it benefits everyone.

10.5. Policy recommendations for STI-based improvement of the mining sector

To help ensure that the recommendations advanced in this section relate to the actual situation in the mining sector it is essential to build a much higher level of trust among mining sector stakeholders. Collaboration between the Government (MMMD, ZEA, ZRA, etc.), ZCCM-IH, ZCM and mining firms and investors is needed to underpin the development of virtuous, self-reinforcing and upward development cycles. At the moment, neither the industry nor the Government seem concerned with resetting relationships.

This situation disfavours innovation which needs enhanced communications, interactions and collaborations. As a centuries old industry, neither party views it as a locus of innovation. There is a perception that employment figures do not justify greater policy involvement. However, the development aspirations of Zambia, as expressed in Vision 2030 and successive NDPs, are demanding, and so it is time to call for a reset of relationships and develop strategic foresight for policy action.

In addition to the general observations presented in this chapter, several specific policy recommendations for energizing an STI-led, inclusive and sustainable, development of the mining sector are presented as follows.

RECOMMENDATION 1**: develop a mining sector policy that goes beyond legal and regulatory prescriptions, in order to build confidence and guide Zambia and mining firms and investors into future win-win positions.**
The policy would have a strong STI component and reach out to other policy domains where cooperation will be critical. The policy would focus on supporting transformative processes.

RECOMMENDATION 2**: address education, capabilities, skills and learning gaps in the mining sector** through **an update of the education and TVET curricula**, including the effective integration of digitalization, and by improving collaboration between industry and academia.

RECOMMENDATION 3**: increase funding for R&D in mining** to strategically reposition the sector and **gain competitive advantage internationally**. Increased funding in this regard can focus on efforts at moving to upstream and horizontal and proximate sectors and industries.

RECOMMENDATION 4**: address the gaps in infrastructure** upgrade existing infrastructure, including digital and ICT, roads, transport and logistics, energy and electricity generation and distribution. Actively explore avenues for integrating STI for digitalization **to create Zambia's 'mining sector of tomorrow'**.

RECOMMENDATION 5**: actively explore avenues for integrating digitalization, alongside research and innovation and invention, in efforts to create Zambia's 'mining sector of tomorrow'.**
The effect would be to broaden access to critical infrastructure within the mining sector and all collaborating firms and industries, while **accelerating the energy and sustainability transitions**.

RECOMMENDATION 6**: ensure mining, public and relevant institutions in Zambia's mining sector re-evaluate and strengthen their governance principles and mechanisms.**

RECOMMENDATION 7**: improve opportunities for local content,** support for technological upgrading, and the digital and entrepreneurial capacities of **micro-enterprises and SMEs involved in the mining sector.**

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Endnotes

1 NEPAD Africa Innovation Outlook Report 2010

2 https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=ZM

3 See: https://data.worldbank.org/; Unemployment, total as percentage of total labour force.

4 See: https://data.worldbank.org/; Unemployment, youth as percentage of total labour force, ages 15-24.

5 See: https://bit.ly/3wZIKQn

6 Interest rates on commercial loans were prohibitively high at the time of writing.

7 See: https://www.cmi.no/publications/6866-zambias-looming-debt-crisis-is-china-to-blame

8 The UN Secretary General, as reported in the Financial Times. See: https://on.ft.com/2OJsGRf

9 See: https://sustainabledevelopment.un.org/content/documents/26305VNR_2020_Zambia_Report.pdf

10 12th Zambia Economic Brief, Idem

11 UN ECA classification

12 Percentage of total labour force, (modelled ILO estimate), data.worldbank.org

13 See: https://african.business/2022/03/apo-newsfeed/coronavirus-zambia-covid-19-statistics-daily-status-update-05-march-2022/

14 See: https://www.eurekalert.org/pub_releases/2021-02/buso-cia021821.php

15 See: https://www.mndp.gov.zm/?wpfb_dl=89

16 Data cited in this discussion is from GII 2020. See: https://www.wipo.int/global_innovation_index/en/2020/

17 Information provided during meeting with the Ministry of Commerce, UNCTAD mission, January 2020.

18 See: http://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/130981/filename/131192.pdf

19 Data above are for 2014. Research conducted by the private for-profit sector is excluded from this factsheet due to lack of available data.

20 See: https://www.g-fras.org/en/world-wide-extension-study/africa/eastern-africa/zambia.html

21 See: https://www.agextonline.com/uploads/3/2/4/3/3243215/final_validated_naess.pdf

22 See: https://pmrczambia.com/wp-content/uploads/2020/10/Analysis-2021-Zambia-National-Budget.pdf

23 Completion rate refers to percentage of the total population in the survey sample of the same age group.

24 UNICEF Data Warehouse, data.unicef.org, Data is for 2018.

25 See: https://worldscholarshipforum.com/best-universities-zambia/

26 See: https://www.mohe.gov.zm/unza-ranked-amongst-the-top-twenty-20-universities-in-africa-12th-october-2020/#:~:text=ONE%20of%20the%20world's%20leading,higher%2Deducation%20institutions%20in%20Africa

27 See: https://www.fao.org/africa/news/detail-news/en/c/1161914/

28 See: https://www.iamat.org/country/zambia/risk/air-pollution

29 See: https://www.getfit-zambia.org/solar

30 See: https://www.pv-magazine.com/2021/03/10/first-ppa-linked-solar-park-in-zambia/

31 See: https://www.mohe.gov.zm/ministry-of-higher-education-launches-sti-science-technology-and-innovation-policy/.

32 Since there are no indications that the responsibilities of the Department of Science, Technology and Innovation will change in its new ministerial home, the observations in this review that refer to the previous role of MoHE remain applicable.

33 See: https://nstc.org.zm/wp-content/uploads/2020/08/NSTC-Final-Strategic-Plan-2019-2021-compressed.pdf

34 The overall mandate calls for research on food science, engineering, nuclear science, textile technology, biotechnology, energy resources, water resources, industrial chemistry, animal production, material science and natural products in attainment of a broad range of NDP7's objectives. In addition to the mandates, NDP7's objectives included enhancing research and development and innovation capacity, promoting small-scale agriculture and export diversification, human health, mitigating the effects of climate change and increasing the role of scientific research in national development.

35 See: http://www.sasscalweathernet.org/

36 The project includes Zambia, Namibia, Botswana, South Africa, and Angola. SASSCAL is funded by the German Federal Ministry of Education and Research (BMBF) and has been in operation since 2012. BMBF provided seed funding and earmarked a total contribution of Euro 50 million for SASSCAL, with an emphasis on research and capacity development in the five thematic areas of agriculture, biodiversity, climate, forestry and water. See: https://www.sasscal.org/wp-content/uploads/2018/06/sasscal_weathernet_flyer_180405.pdf

37 These treaties and conventions include, the Beijing Treaty on Audiovisual Performances, the Berne Convention, the Madrid Protocol, the Nairobi Treaty, the Paris Convention, the Patent Cooperation Treaty, the Patent Law Treaty, the WIPO Convention, and the Washington Treaty. See: https://wipolex.wipo.int/en/treaties/ShowResults?country_id=191C

38 See: https://iclg.com/practice-areas/patents-laws-and-regulations/zambia

39 See: https://wipolex.wipo.int/en/members/profile/ZM

40 WIPO (2019): 2019 saw the registration of an additional 158 patents in Zambia from abroad.

41 Figures at time of writing.

[42] Detailed information can be found in the Annual Report 2019 of the Zambia Bureau of Standards.

[43] Detailed data can be found in the Annual Report 2019 of the Zambia Metrology Agency.

[44] See: https://docs.google.com/file/d/1OTO5VdpZwbCKRj4O8R2ZouvTAJtR1CYR/view

[45] See: http://www.xinhuanet.com/english/2020-11/17/c_139522943.htm

[46] The scheme is operated by the Madison Bank Group.

[47] The Energy and Environment Partnership Trust Fund (EEP Africa) is a clean energy financing facility hosted and managed by the Nordic Development Fund (NDF) with funding from Austria, Finland and the NDF.

[48] A 2014 enquiry (The Ministry of Youth and Sport, 2018) shows relatively low levels of violence (both general and sexual) in Zambia among people aged 18 to 24 reporting on violence experienced prior to the age of 18. The enquiry included Nigeria, Zimbabwe, Tanzania, Malawi, Kenya, Haiti and Cambodia. Countries referenced by the survey had rates of between 20 to 100 per cent higher than in Zambia (with the exception of Cambodia, for sexual violence).

[49] Stakeholders were engaged through, "… workshops, meetings, roundtable discussions and solicited written submissions. In addition, joint government-civil society organisations symposia were held at national and regional levels with the aim of putting Zambia's development agenda, vis-à-vis sustainable development and poverty reduction, into perspective" (NDP7).

[50] See: http://hdr.undp.org/en/content/gender-inequality-index-gii

[51] The emancipation of women is a, "…(p)rocess, strategy and myriad efforts by which women have been striving to liberate themselves from the authority and control of men and traditional power structures, as well as to secure equal rights for women, remove gender discrimination from laws, institutions and behavioural patterns, and set legal standards that shall promote their full equality with men." See: https://eige.europa.eu/thesaurus/terms/1098

[52] See: ZICTA Annual Report 2019 and http://onlinesystems.zicta.zm:8585/statsfinal/ICT%20Indicators.html

[53] See: https://blogs.worldbank.org/africacan/more-than-a-short-term-escape-sustainable-empowerment-solutions-for-girls-and-women-in-zambia

[54] Detailed data can be found in the 2018 Maternal Perinatal Death Surveillance Review of the Zambia National Public Health Institute.

[55] A detailed discussion can be found here: https://onlinelibrary.wiley.com/doi/epdf/10.1111/j.1471-1842.2010.00876.x

[56] See: https://theconversation.com/what-its-really-worth-to-pipe-water-to-homes-in-rural-zambia-155149

[57] See: https://jibuco.com/how-we-do-it/

[58] See: https://blogs.worldbank.org/africacan/more-than-a-short-term-escape-sustainable-empowerment-solutions-for-girls-and-women-in-zambia

[59] See: https://www.worldbank.org/en/news/press-release/2020/07/28/world-bank-continuous-support-to-empower-zambias-women-girls-and-the-poorest-households

[60] See: https://awardfellowships.org/gaia/

[61] See: https://awardfellowships.org

[62] See: https://www.business-humanrights.org/en/latest-news/zambia-alternative-mining-indaba-urges-govt-to-curb-illicit-financial-flows-and-to-ensure-mining-benefits-poor-communities/

[63] See: https://miningforzambia.com/5-things-didnt-know-women-mining/

[64] See: https://internationalwim.org/first-lady-of-zambia-calls-for-more-women-in-mining/

[65] See: https://www.britishcouncil.org/partner/international-development/news-and-events/june-2017/increasing-women%27s-representation-in-politics-in-Zambia

[66] International Monetary Fund (2020): the importance of, "the spread and use of digital technologies – the Internet, mobile phones, and other tools and processes – to collect, store, analyse, and exchange information digitally".

[67] World Bank (2020b): Zambia's Digital Transformation Journey: Strides Made, but Key Gaps Remain, June 24, 2020. See: https://www.worldbank.org/en/country/zambia/publication/zambia-digital-economy-transformation-journey-strides-made-key-gaps-remain

[68] World Bank: Zambia Making Strides in Transforming Economy. See: https://www.zambiaembassy.org/article/zambia-making-strides-in-transforming-economy-world-bank

[69] See: https://networkreadinessindex.org/

[70] See: https://infratel.co.zm/

[71] See: https://itweb.africa/content/raYAyModNanqJ38N

[72] See: https://www.worldbank.org/en/programs/all-africa-digital-transformation

[73] See: https://www.szi.gov.zm/

[74] See also, for example: https://zambia.co.zm/news/headlines/2020/06/24/boz-governor-taps-into-digital-economy/; and, Bank of Zambia urges country to embrace financial technology, https://www.centralbanking.com/central-banks/payments/4176516/bank-of-zambia-urges-country-to-embrace-financial-technology

[75] See: http://healthenabled.org/wordpress/zambia-digital-health-dashboard/

[76] See: https://bongohive.co.zm/

[77] See: https://fintech4u.co.zm/

[78] See: https://www.jacarandahub.org/

[79] See: https://lusaka.impacthub.net/

[80] See: https://zamren.zm/

[81] Ministerial Statement on Progress of the Smart Zambia Vision. See: https://bit.ly/3oe1bwG. See also: World Bank (2020a): Digital Transformation of Agriculture, Education and Health (p. 126); FAO (2020).

[82] See: https://bit.ly/3fgcjVo

[83] See: https://vc4a.com/ventures/e-msika-services-limited/

[84] See: https://www.emsika.com/

[85] The regional trade agreements include the African Continental Free Trade Agreement, the Common Market for Eastern and Southern Africa and the Southern African Development Community.

[86] Financial inclusion may be defined as, "Access to and informed usage of a broad range of quality and affordable savings, credit, payment, insurance, and investment products and services that meet the needs of individuals and businesses" (MoF, 2017).

[87] Digital finance from the ground up: The case of Zambia, (26 October 2018). See: https://europa.eu/capacity4dev/articles/digital-finance-ground-case-zambia

[88] World Bank: Zambia Making Strides in Transforming Economy. See: https://www.zambiaembassy.org/article/zambia-making-strides-in-transforming-economy-world-bank

[89] See: https://unctad.org/news/zambias-e-commerce-firms-stay-course-amid-pandemic

[90] See: https://www.wfp.org/countries/zambia

[91] See: https://www.wfp.org/countries/zambia

[92] See: https://www.musika.org.zm/

[93] See: https://www.timbali.co.za/

[94] See: the project of the Agri Leasing Company of Zambia in collaboration with the KfW Development Bank, and Financial Sector Deepening Limited (2017).

[95] See: https://www.mfl.gov.zm/?page_id=5084

[96] See: https://projects.worldbank.org/en/projects-operations/project-detail/P094183

[97] See: https://www.reuters.com/world/middle-east-africa/zambia-achieves-record-high-copper-production-2020-minister-says-2021-02-23/

[98] See : https://www.statista.com/

[99] Mbilima (2019); Sánchez and Hartlieb (2020); ZEC (2020); ESMAP ***et al.*** (2005); Sequeira ***et al.*** (2016); Kragelund (2017); MNDP (2017).

[100] i.e., made available for pollution in a supervised manner.

[101] The MMDA will refer in the text of this review to the 2015 MMDA and its amendments in 2016.

[102] For a summary of some these policies and detailed discussions see, for example, Kragelund (2017), and the Government of Zambia's Ministry of Commerce, Trade and Industry (MCTI) website.

[103] See: https://iclg.com/practice-areas/mining-laws-and-regulations/zambia

[104] See: https://www.business-humanrights.org/en/latest-news/zambia-govt-accuses-mining-companies-of-undervaluing-minerals-to-avoid-paying-taxes

[105] See: https://www.ft.com/content/35c58b5f-f890-4390-967a-28c0a0a1fb50, https://www.economist.com/international/2021/03/04/poor-countries-struggling-with-debt-fight-to-get-help, and https://odi.org/en/insights/four-lessons-from-zambias-emerging-debt-default/, https://cuts-lusaka.org/pdf/Understanding_the_Impact_of_Zambias_Growing_Debt_on_Different_Stakeholders.pdf

[106] See: https://www.bbc.com/news/world-africa-55725305#:~:text=More%20than%202%2C500%20Zambian%20villagers,KCM)%2C%20a%20Vedanta%20subsidiary.

[107] See: https://www.reuters.com/world/middle-east-africa/vedanta-resources-settles-zambia-copper-mine-pollution-claim-2021-01-19/

[108] See: https://www.lme.com/en-GB/Metals/Non-ferrous/Copper#tabIndex=2

[109] A beneficial owner (private investors in the mining sector) is a person who enjoys the benefits of ownership even though the title is in the name of a legal owner (Zambian Government and society).

[110] The text that follows is largely adapted from the Zambia EITI Beneficial Ownership Roadmap.

[111] See: http://mines.org.zm/teveta-signs-k2-million-deal-with-the-zambia-chamber-of-mines-to-improve-mine-safety/

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