Technology Needs Assessment - Lesotho

Lesotho

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List of acronyms

AI	Artificial Intelligence
AIDS	Acquired Immunodeficiency Syndrome
AR	Augmented Reality
AU	African Union
B_2B	Business to Business
COVID-19	Coronavirus disease of 2019
CSO	Civil Society Organization
FAO	United Nations Food and Agriculture Organisation
FDI	Foreign Direct Investment
FTE	Full Time Equivalent
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on R&D
GNI	Gross National Income
GPS	Global Positioning System
GSM	Global System for Mobile Communications
HIV	Human Immunodeficiency Virus
ICT	Information and Communication Technologies
IFF	Illicit Financial Flow
IPR	Intellectual Property Rights
LCA	Lesotho Communications Authority
LDC	Least Developed Country
LEWA	Lesotho Electricity and Water Authority
LMS	Lesotho Meteorological Services
MoET	Ministry of Education and Training
MOF	Metal-Organic Framework
NCDC	National Curriculum Development Centre
NEPAD	New Partnership for Africa's Development
NGO	Non-Governmental Organisation
NO	Nitric Oxide
NSDP	National Strategic Development Plan
NUL-ERC	National University of Lesotho Energy Research Centre
ODA	Official Development Assistance
PV	Photovoltaic
SADC	Southern African Development Community

SDG	Sustainable Development Goals
SME	Small and Medium Enterprises
SNHU	Southern New Hampshire University
SST	Slurry-Separation Technology
STEM	Science, Technology, Engineering and Mathematics
STI	Science, Technology and Innovation
SWOT	Strengths, Weaknesses, Opportunities and Threats
TNA	Technology Needs Assessment
TVET	Technical Vocational Education and Training
UAV	Unmanned Aerial Vehicles
UN	United Nations
UNDP	United Nations Development Programme
UNTBLDC	United Nations Technology Bank for Least Developed Countries
USF	Universal Access Fund
VNR	National Voluntary Review

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Foreword

The relationship between human development and technology has increased in intensity in recent years. Successive technology inventions and incremental advances have thus alleviated or ameliorated notable development obstacles and contributed to improvements in quality of life globally. If thoughtfully and comprehensively implemented, technology can be a fundamental tool in attaining sustainable development. While it is commonly believed that technology is just machines, various products and software, it is also comprised of knowledge and processes used to design, make, manage and operate the technological products – technical expertise and literacy are also key components of technology.

In the priority sectors identified in the report; we must deploy scalable emerging technologies while upgrading and maintaining them in a timely manner to ensure a technology-advanced economy that positively contributes directly to the life of each Mosotho citizen. Technology can be a powerful solution for addressing current world challenges such as climate change and biodiversity loss as well as sudden global crisis such as the Covid-19 pandemic and its aftermath. If the diffusion and transfer of technology is human-centred and rooted in the principles of South-South cooperation and inclusive design, they can provide significant opportunities for our country to achieve the Sustainable Development Goals (SDGs).

This Technology Needs Assessment (TNA) Report for Lesotho supported by the United Nations Technology Bank for Least Developed Countries (UNTBLDC) is designed to identify priority sectors and needed technologies for improving efficiency, and effective implementations and informed decision making for sustainable development. In particular, it highlights the key role of strengthening technical and vocational education and training (TVET) structures and curriculums to strengthen Lesotho's STI ecosystem. Connectivity such as affordable internet was also identified as cross-cutting theme which can bolster performance of all key sectors.

The Ministry of Communications, Science and Technology (MCST) would like to assure all stakeholders that we are committed to the effective and considered implementation of the recommendations of the TNA report through deployment of modern and indigenous technology. This report is the result of the dedicated efforts of all those involved from the beginning: the Department of Science and Technology (DST), UN Technology Bank, Commonwealth Secretariat, and all stakeholders.

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Finally, DST would like to thank all institutions that provided technical and financial support towards the launch of the TNA report. The full list of contributing organizations can be found in the references section of this report.

Executive Summary

This report presents the technology needs assessment (TNA) for Lesotho conducted with support by the UN Technology Bank for Least Developed Countries (UNTBLDC) conducted between May and December, 2021. The overarching objective of the UNTBLDC is to help the Least Developed Countries (LDCs) build the science, technology and innovation (STI) capacity that they need to promote the structural transformation of their economies, eradicate poverty and foster sustainable development. The objectives of this study are therefore the identification of appropriate technologies for Lesotho to contribute to the realisation of sustainable development goals (SDGs) and eradicate poverty, and the strengthening of the STI capacity of the country to identify, absorb, develop, integrate and scale-up the deployed technologies and innovations.

In this study, a technology is defined as both a physical component, such as a product, equipment, device, blueprint and process, and an informational component such as know-how and technical knowledge. The methodology used is a mixed method approach, including the collection and analysis of primary and secondary data. For primary data collection, an online survey and focus group meetings with representatives of different stakeholders were implemented.

Background

Lesotho is located in Southern Africa and is completely encircled by the Republic of South Africa but separated from it by important mountain ranges. It has a population of about 2.1 million with an estimated annual population growth of 0.8% in 2018.[1] Lesotho's youth forms 39.6% of the total population. The majority of the population (58%) is concentrated in rural areas and are dependent on subsistence farming for living. Although the country suffered greatly during the height of the HIV/AIDS epidemic, from 2006 onward the number of reported deaths has declined by more than half in a decade, from 49,343 (2006) to 23,004 (2016).[2]

Water is one of the main natural resources of Lesotho. The rivers are not only crucial in the provision of fresh water, but also play an important role in energy generation in the form of hydroelectric power. It is also an export commodity of the country, as Lesotho is the main provider of water to neighbouring South Africa's province of Gauteng.[3]

The structure of Lesotho's economy has changed significantly from the one dominated by agriculture, real estate and government services to the one dominated by manufacturing, retail and services. Still, agriculture remains critical for supporting the livelihoods of those living in rural areas, where more than 70% of households are dependent on subsistence farming. However, arable land suitable for agriculture is below 10% (270,000 hectares) of total land area (3 million hectares). Increased use of natural resources for farming, grazing and fuel results in high environmental degradation, posing both economic and governance challenges. In addition, mining of diamonds is a growing activity.[4]

Lesotho remains vulnerable to the COVID–19 pandemic after emerging from a second wave of infections at the start of 2021. According to the World Bank, its real GDP is expected to contract by 5.3% in 2020 due to the impact of COVID-19, compared to an expansion of 0.4% that was expected before the pandemic. The pandemic has exacerbated Lesotho's weak macroeconomic performance and budgetary constraints leading to limited fiscal capacity to respond to shocks.[5]

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1 World Bank, 'Population Growth (Annual %) - Lesotho, Sub-Saharan Africa (Excluding High Income), Least Developed Countries: UN Classification | Data', accessed 10 August 2021, https://data.worldbank.org/indicator/SP.POP.GROW?locations=LS-ZF-XL.

2 Government of Lesotho, 'National Strategic Development Plan II 2018/19-2022-23', n.d., https://www.gov.ls/wpcontent/uploads/2021/06/National-Strategic-Development-Plan-II-2018-19-2022-23.pdf.

3 World Atlas, 'What Are the Major Natural Resources of Lesotho?', WorldAtlas, 14 August 2019, https://www.worldatlas.com/articles/what-are-the-major-natural-resources-of-lesotho.html.

4 UN, 'United Nations Development Assistance Framework Foe Lesotho 2019-2023', 2018, https://lesotho.un.org/sites/default/files/2019-10/Lesotho%20UNDAF%202019-2023_final%20design.pdf. Government of Lesotho, 'Lesotho's Vision 2020', n.d., http://www.gov.ls/wpcontent/uploads/2018/04/National_Vision_Document_Final.pdf.

5 https://www.worldbank.org/en/country/lesotho/overview#1

According to the Global Competitiveness Index 2019, the country needs to foster the development of the private sector and promote efficient use of its limited resources. The areas that need most attention are the following: infrastructure which facilitates private sector investments by lowering production costs and opening new markets, thereby creating new production, trade, and profit opportunities and; financial systems which constrain private sector investment, particularly for micro, small, and medium sized enterprises. The underdeveloped local business enterprise sector is also evident by the prevalence of foreign companies operating in the local market, and low ICT adoption by local companies. For example, only 15% of formal firms have a website and 45% use e-mail, which is much lower than the average for Sub-Saharan Africa.[6]

In 2000, Lesotho had one of the highest literacy rates in sub-Saharan Africa at 86% of population aged 15 and over. Although the performance is declining (with 77% in 2014); it is still above the sub-Saharan Africa rate of 63% and least developed countries rate of 60%. Basic and tertiary education receive the highest share of the education budget in Lesotho. An important component of the tertiary education budget and consequently the overall education budget are bursaries programmes to support all students, benefiting especially the poorest and most marginalised. On the other hand, the budget spent on technical and vocational education and training (TVET) is very low at 0.86% during 2020-21. Lesotho suffers from skills mismatches and the lack of entrepreneurship programmes for growth-oriented businesses, limiting the competitiveness of the private sector.[7]

STI system and policy framework

The national STI system of Lesotho is at an early stage of development. The government expenditure on R&D in 2015 was USD 0.44 million PPP which corresponds to 0.01% of the GDP. Lesotho had in 2015 approximately 62 researchers per million inhabitants, a number much below critical mass estimation for developed countries (i.e., 1000/1200 FTE researchers per million inhabitants). It ranked 5th out of the six countries in the number of researchers that have data in the Africa Innovation Outlook III for the government and the higher education sector. Lesotho ranks last out of seven selected Southern African countries in the total number of scientific publications between 2011 and 2019. According to the African Innovation Outlook III, some 75% of 36 firms surveyed in Lesotho were categorised as innovative. Firms in Lesotho mainly conducted innovation in goods (44.4%) and processes (44.4%).[8]

In 2021, the Government of Lesotho embarked on the task of updating the national STI policy. As of October 2021, the policy is still under development. The overall vision of the previous STI policy of Lesotho 2006-11 is “A free, prosperous and progressive economy and society sustained through intelligent use of S&T assets by progressive and innovative citizens, corporations and government”.[9]

The STI system of Lesotho is dominated by the public sector institutions and functions with weak connections between different national stakeholders. The country also lacks an oversight body to strengthen the linkages between industry, academia, government, and the society.

Technology needs and implementation plan

The technology needs for Lesotho have been assessed through a three-step process. First, issues and technologies were identified for the following priority sectors by the national stakeholders: agriculture and food, conservation and environment, education, and arts, culture, and heritage sector. Then, based on the needs and issues expressed by the stakeholders and identified in the

6 Anna Reva, ‘Unlocking the Potential of Lesotho’s Private Sector: A Focus on Apparel, Horticulture, and ICT’, 2018, http://documents.worldbank.org/curated/en/832751537465818570/Unlocking-the-potential-of-Lesotho-s-private-sector-a-focus-on-apparel-horticulture-and-ICT

7 UNICEF. ‘Education Budget Brief Fiscal Year 2020/21’, 2020. https://www.unicef.org/esa/media/8726/file/UNICEFLesotho-Education-Budget-Brief-2020-21.pdf

8 AUDA-NEPAD, ‘African Innovation Outlook III’, 2019, https://au.int/sites/default/files/documents/38122-docaio_3rd_edition_final_eng_repro.pdf.

9 Government of Lesotho, ‘Lesotho Science & Technology Policy 2006-2011’.

secondary sources, the study team investigated the available transferable technologies which have the potential of highest positive impact. The final input for the TNA was received from the stakeholders both during the focus groups and the validation workshop organised under the study. As a result, a preliminary TNA implementation plan was prepared for the technologies that needs to be prioritised for Lesotho in the short term, medium term, and long term. For example, one of the cross-cutting issues for the four prioritised sectors was limited internet access. For agriculture and food, the main issues identified were low agricultural production and productivity; for conservation, inadequate water resource data collection and management; for education, it was low infrastructure to support eLearning and ineffective TEVET system; and for arts, cultural and heritage; it was threatened heritage sites calling for close monitoring. Other priority sectors were health and energy.

Conclusions and recommendations

The technology needs for Lesotho were assessed by the national stakeholders for the following priority sectors: agriculture and food, conservation and environment, education, and arts, culture and heritage. In addition, the study team identified available transferable technologies prioritised for Lesotho with the potential of highest positive impact.

As summarised above and discussed in the following sections, Lesotho is making notable progress in developing and implementing STI policies, and enhancing its national STI system. The high commitment of the government on STI and the strengths and potential of the country create a strong foundation for it sustainable and inclusive development and graduation from the LDC category.

Within this framework, Lesotho will hugely benefit from the adoption and deployment of technologies addressing the needs of the priority sectors as well as the development of necessary skills and competencies for the use and development of them.

Therefore, it is recommended that the government

- Establishes a high-level oversight body for the coordination of STI policy implementation, and establishment of multi-stakeholder dialogue, design of a coherent STI policy mix, and integration of STI in other policy areas
- Creates the systems and builds capacities to regularly collect internationally comparable STI statistics as well as monitoring and evaluation mechanisms for policies and policy instruments
- Builds a balanced STI policy mix targeting not only start-ups and technology-based enterprises but also grass-roots innovators
- Develops human capital for STEM fields and attracts young people to pursue research career paths and innovation-based entrepreneurship, with a particular focus on attracting girls to STEM subjects to increase the participation of women in research and innovation
- Reviews and harmonises the regulatory framework and quality standards for TVET with the international best practices, increases investments in TVET with a particular focus on practical implementation and ensures private sector involvement in curriculum development and implementation including but not limited to apprenticeship programmes
- Enhances communication and collaboration between research performers and the private sector, also by integrating the FDI in the innovation ecosystem Invests in developing the quality, metrology and standardisation infrastructure, and offer internationally recognised certification in all sectors
- Establishes and strengthens research institutes to conduct and commercialise R&D in the priority areas

- Mainstream STI in the policies, programmes and projects implemented by the government and development partners.
- Establishing a university focusing on agricultural research and innovation and offering graduate and postgraduate degrees.
- Developing TVET programmes and infrastructure to create a supply of intermediate-level employees (laboratory technicians, radiographers, renewable energy and energy efficiency experts, etc.) to be engaged in STI in the priority sectors

To support sustainable and inclusive development of Lesotho, it is recommended that the UN Technology Bank and other development actors assists Lesotho in

- The transfer and deployment of technologies identified and listed in this report giving the priority to those listed in the implementation plan
- Developing necessary skills and capabilities in technology transfer and development
- Establishing an effective IP system, and drafting and enforcing the IPR -related legislation
- Raising awareness for the adoption and use of new technologies
- Creating a national technology transfer office to coordinate the technology adoption process as well as commercialisation of R&D outputs from universities, research institutes and start-ups
- Establishing an incubator/accelerator lab to foster R&D and innovation in biotechnology and biosafety for the agriculture and food sectors

CHAPTER 1
Science, Technology and Innovation Review and Technology Needs Assessment for Lesotho

1 Introduction

The technology needs assessment (TNA) for Lesotho conducted with support by UN Technology Bank for Least Developed Countries (UNTBLDC). The overarching objective is to build the science, technology and innovation (STI) capacity of the Least Developed Countries needed to promote the structural transformation of their economies, eradicate poverty and foster sustainable development. Its specific objectives, as outlined in its Charter, are to[1]

- Strengthen the STI capacity of LDCs, including the capacity to identify, absorb, develop, integrate and scale-up the deployment of technologies and innovations, including indigenous ones, as well as the capacity to address and manage Intellectual Property Rights issues;
- Promote the development and implementation of national and regional STI strategies;
- Strengthen partnerships among STI-related public entities and with the private sector;
- Promote cooperation among all stakeholders involved in STI, including, researchers, research institutions, public entities within and between LDCs, as well as with their counterparts in other countries;
- Promote and facilitate the identification, utilisation and access of appropriate technologies by LDCs, as well as their transfer to the LDCs, while respecting intellectual property rights and fostering the national and regional capacity of LDCs for the effective utilisation of technology in order to bring about transformative change.

To realise these objectives, the UNTBLDC implements a number of activities through partnerships and direct support to build STI capacities, ecosystems and regulatory frameworks that can harness the benefits of newly available technologies by[2]

1. Attracting outside technology and facilitating technology transfer on voluntary and mutually agreed terms and conditions;
2. Supporting homegrown innovation and research; and
3. Bringing imported and indigenous technologies to market

Lesotho is among the LDCs for which the TNA studies was launched in 2021 by the UNTBLDC.

The remainder of this report is organised as follows: The second section gives an overview of the contextual background that shapes the framework in which STI policies and interventions are formulated and implemented. The third section describes the current status of the STI system and policy framework in the country. An analysis of the STI-related strengths, weaknesses, opportunities and threats (SWOT) for Lesotho is given in the fourth section. The fifth section gives the assessment of the technology needs of the country as expressed by the stakeholders through surveys and focus group meetings. The sixth section presents a list of available transferable technologies prioritised for Lesotho with the potential of highest positive impact. The seventh section provides an implementation matrix that Lesotho can use in identifying technologies that can implemented in the short term, medium term and long term. The last section provides a summary of conclusions as well as the recommendations formulated for the Government of Lesotho and other development actors including the UNTBLDC.

1.1 Methodology

The main objectives of the TNA study are to i) Provide critical insights into the functioning of national frameworks on science, technology and innovation in LDCs; ii) Identify the core areas of focus for each country and specific initiatives to maximize the impact of technology as an instrument to foster structural

1 UN, 'Charter of the Technology Bank for the Least Developed Countries', 2016, https://undocs.org/A/71/363.
2 UNTBLDC, 'Supporting the Operationalization of the Technology Bank for the Least Developed Countries: A 3-Year Strategic Plan', 2016, http://unohrlls.org/custom-content/uploads/2016/08/Strategic-Plan-of-the-Technology-Bank-for-the-LDCs-8-August-2016.pdf.

transformation, reduce poverty and promote sustainable development; iii) Identify priority sectors in the country and identify and prioritize technologies that can adequately and effectively address the country needs in the focus sector(s); iv) Improve the coordination between the different authorities in the country working on STI and technology issues; and v) Develop a technology implementation plan to support the transfer, adaptation, and implementation of validated priority technologies.

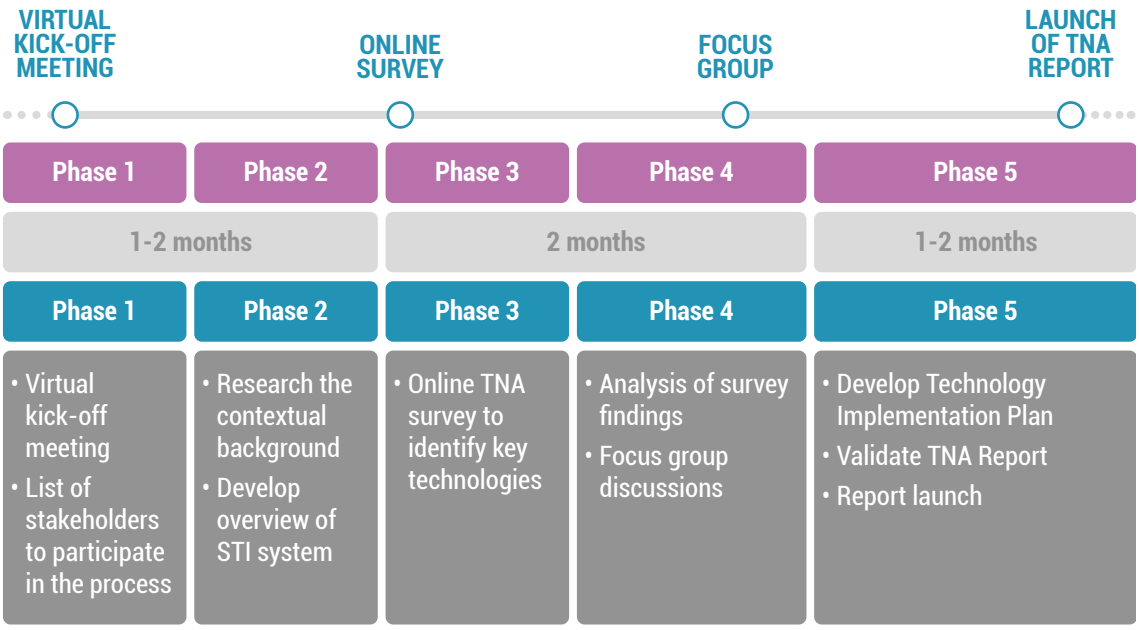
In this study a technology is defined as both a physical component, such as a product, equipment, device, blueprint and process, etc., and an informational component such as know-how and technical knowledge.

The methodology used was a mixed method approach, including the collection and analysis of primary and secondary data. For primary data collection, an online survey and focus group meetings with representatives of different stakeholders were implemented.

Figure 1 describes the timeline and process undertaken during the study.

The initial online survey implemented between August and September in collaboration with the Ministry of Communications, Science and Technology aimed at collecting information on technology needs in key sectors and was answered by 16 participants. This was used as the basis for the focus group meetings conducted by the study team with the participation of the national stakeholders. The secondary data and information sources reviewed included documentation published by national and international organisations.

Figure 1. Technology Needs Assessment process



CHAPTER 2
Overview of the contextual background

Lesotho is a country in Southern Africa completely encircled by the Republic of South Africa but separated from it by important mountain ranges. Two-thirds of Lesotho consists of mountains. It has a population of about 2.1 million with an estimated annual population growth of 0.8% in 2018, a figure below the aggregated growth rate of Sub-Saharan Africa (excluding high-income countries) of 2.6%.[1]

Lesotho's youth (15-35years) comprise 39.6% of the total population while the elderly (aged 65 years and above) comprises only 6.1%. The majority of the population (58%) is concentrated in rural areas and are dependent on subsistence farming for survival. Recurrent droughts have impacted agricultural productivity, resulting in frequent food security crises for vulnerable households and children. Although Lesotho suffered greatly during the height of the HIV/AIDS epidemic, from 2006 onward the number of reported deaths has declined by more than half in a decade from 49,343 (2006) to 23,004 (2016).[2]

Water is one of the main natural resources of Lesotho. The country is home to many rivers that constitute its main water sources. The Orange River, the region's largest river, has many of its tributaries and its primary catchment area is found in the country. The rivers are not only crucial in the provision of fresh water in Lesotho, but they also play an important role in energy generation in the form of hydroelectric power. It is also an export commodity of the country as Lesotho is the main source of water for neighbouring South Africa's province of Gauteng. The water is exported to South Africa through the Lesotho Highlands Water Project, the largest such project on the continent.[3]

Lesotho has extreme climatic conditions characterised by droughts, floods, strong winds, early/late frosts, hail, and snowstorms. Increasingly warmer temperatures and lower levels of rainfall have significant implications for agriculture, food security, poverty and vulnerability, as the agriculture accounts for livelihoods of 70% of the of population, and most of the population live in rural areas. Moreover, arable land suitable for agriculture is below 10% (270,000 hectares) of total land area (three million hectares). Increased use of natural resources for farming, grazing and fuel results in high environmental degradation, posing both economic and governance challenges.[4]

2.1 Development agenda

The development agenda of Lesotho is shaped by its Vision 2020 document[5] which aspires to "be a stable democracy, a united and prosperous nation at peace with itself and its neighbours". It aims that the country "shall have a healthy and well-developed human resource base. Its economy will be strong, its environment well managed and its technology well established". To achieve this vision, the document establishes the following focus areas:

- **A stable democracy** focusing on an effective and corruption-free governance system with clear direction in policy development, strategic thinking and foresight and programme planning, as well as promoting freedom of expression.
- **A united nation** focusing on fostering common goals based on common cultural heritage. The Monarchy will continue to play the most important role of unifying the nation.
- **A nation at peace with itself and its neighbours** focusing on peaceful and strong strategic relations with the Republic of South Africa and a full proactive involvement with other countries, regional and global institutions. The nation will successfully deal with its challenges including crime, unemployment and poverty.

1 World Bank, 'Population Growth (Annual %) - Lesotho, Sub-Saharan Africa (Excluding High Income), Least Developed Countries: UN Classification | Data', accessed 10 August 2021, https://data.worldbank.org/indicator/SP.POP.GROW?locations=LS-ZF-XL

2 Government of Lesotho, 'National Strategic Development Plan II 2018/19-2022-23', n.d., https://www.gov.ls/wp-content/uploads/2021/06/National-Strategic-Development-Plan-II-2018-19-2022-23.pdf

3 World Atlas, 'What Are the Major Natural Resources Of Lesotho?', WorldAtlas, 14 August 2019, https://www.worldatlas.com/articles/what-are-the-major-natural-resources-of-lesotho.html

4 UN, 'United Nations Development Assistance Framework For Lesotho 2019-2023', 2018, https://lesotho.un.org/sites/default/files/2019-10/Lesotho%20UNDAF%202019-2023_final%20design.pd

5 Government of Lesotho, 'Lesotho's Vision 2020', n.d., http://www.gov.ls/wp-content/uploads/2018/04/National_Vision_Document_Final.pdf

- **A healthy and well-developed human resource base** focusing on good quality health system with facilities and infrastructure accessible and affordable to all. Likewise, focusing on access to quality education fully responsive to the country's needs, accessible at all levels.
- **A strong economy and prosperous nation** focusing on vibrant economy with a strong industrial base will fully exploit the potential for locally available natural resources. The tourism potential will be fully exploited and the foundation for industrialization will be well established.
- **A well-managed environment** focusing on strengthening its position in environmental management that protects and supports the country's diversity of life systems.
- **A well-advanced technology** focusing on developing a solid foundation for technological research and development starting from strengthening school curricula, expand its usage of applied

The Vision 2020 is operationalised through the National Strategic Development Plan 2018/19-2022/23 (NSDP II)[6] which in turn it also aims at implementing the SDGs, African Uni Agenda 2063 Goals and Southern Africa Development Community (SADC) Regional Indicative Strategic Development Plan. NSDP II emphasises private sector development and gives priority to pursuing people-centred development and establishes four key strategic goals with its respective intermediary outcomes (Table 1).

Table 1. Key Priority Areas and Intermediary outcomes of the NSDP II

Key Priority Area	Intermediary Outcome
Enhancing inclusive and sustainable economic growth and private sector-led job creation	• Sustainable commercial agriculture and food security • Diversified products and effective business linkages • Operational industrial clusters and integrated supply chain • Improved and diversified tourism products • Improved Creative industry • Strengthened research for policy making and product development • Functioning incubation centres • Improved use of ICT
Strengthening human capital	• Enhanced skills for employment and sustainable inclusive growth • Resilient healthcare systems and improved healthcare outcomes • Reduced malnutrition • Efficient social protection programmes and reduced vulnerability • Improved migration management
Building enabling infrastructure	• Sustainable quality transport network • Sustainable energy production and use • Sustainable production, use of water resources, and improved sanitation and hygiene • Economic-friendly ICT infrastructure • Improved quality of built environment • Sustainable solid waste management
Strengthening national governance and accountability systems	• Improved public financial management and accountability • Effective oversight institutions • Improved service delivery • Peace, security and stability • Respect for human rights and protection of civil and political rights for all • Effective, transparent, efficient and equitable justice systems • Improved corporate governance and protection of investor rights • Stable labour markets • Improved planning and reliable statistics for monitoring and evaluation • Improved cooperation and relations between Lesotho and other nations • Informed nation

Source: Government of Lesotho. 'National Strategic Development Plan II 2018/19-2022-23', n.d.

6 Government of Lesotho, 'National Strategic Development Plan II 2018/19-2022-23', 23.

According to the Human Development Index[7] of the UNDP (Figure 2), between 1990 and 2019,

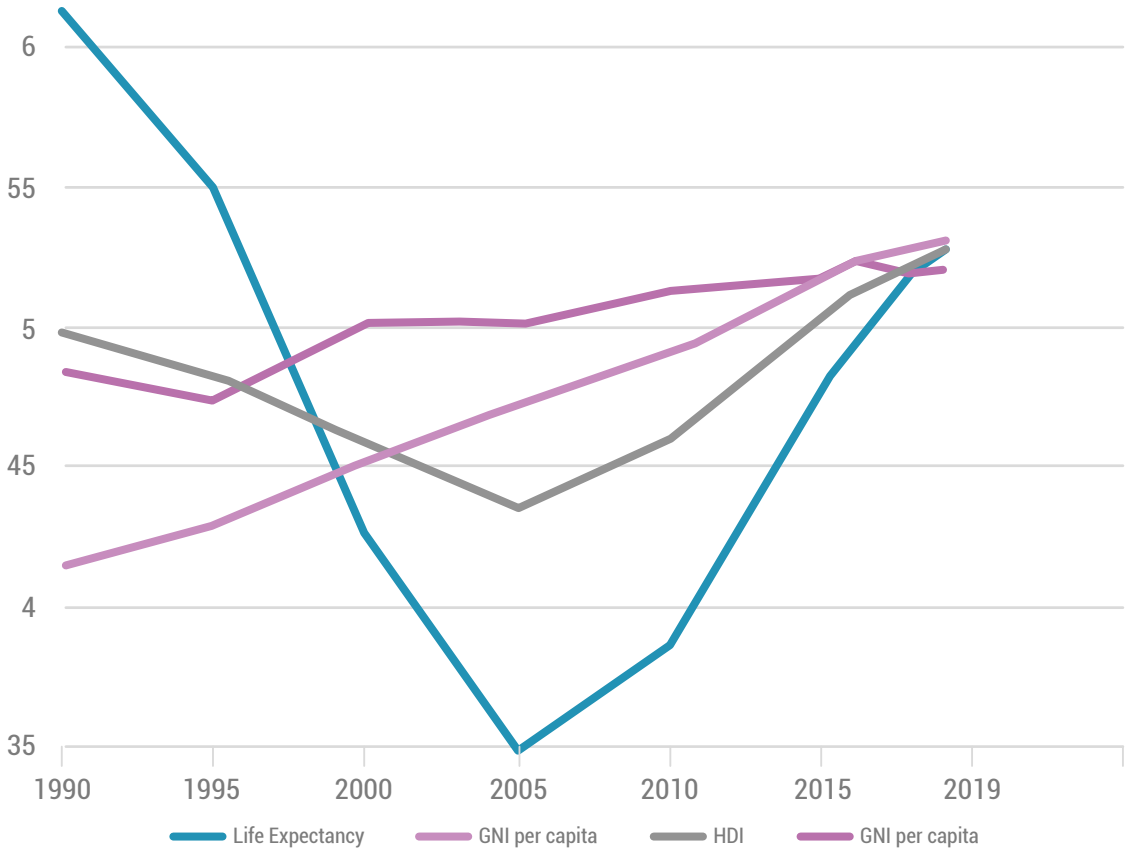
- Lesotho's HDI value increased from 0.498 to 0.527
- Life expectancy at birth decreased by 5.5 years (from 59.8 to 54.3 years)
- Mean years of schooling increased by 2.1 years
- Expected years of schooling increased by 1.7 years
- Gross National Income per capita increased by about 26.8 percent.

In 2019, Lesotho produced the Voluntary National Review Report highlighting the progress achieved in the implementation of the SDGs.[8] In this report, Lesotho highlighted progress made in SDG 1 "No poverty" stating that between 2002/2003 and 2017/2018, the national poverty and extreme poverty head- count ratios declined from 56.6% to 49.7% and from 34.1% to 24.1%, respectively. Similarly, notable progress was achieved for SDG 2 "Zero hunger" with declining chronic malnutrition declining by approximately 10% and acute malnutrition declining by approximately 3% between 2004 and 2014.

2.2 Political and economic environment

Lesotho is a constitutional monarchy with a mixed proportional parliamentary system that consists of a senate and a national assembly. The king is the head of state, and the democratically elected prime minister is the head of the government and has executive authority. In recent years, Lesotho has experienced political instability emanating from volatile government coalitions. In June 2012, Lesotho established its first coalition government which collapsed after two years in power. The culmination of events

Figure 2. Human Development Index of Lesotho. *Source: UNDP, 2020*



7 http://hdr.undp.org/sites/default/files/Country-Profiles/LSO.pdf
8 World Bank, 'Overview', Text/HTML, World Bank, accessed 11 August 2021, https://www.worldbank.org/en/country/lesotho/overview.

subsequently led to three general elections within a period of five years (between 2012 and 2017), all resulting in coalition governments.[9] The last elections were held in June 2017, leading to a four-party coalition government whose composition changed when the previous Prime Minister stepped down mid-term in May 2020. The next election is expected to be held in 2022.[10]

ODA is an important source of resources for Lesotho. Nevertheless, the country's efforts to accurately report ODA are recent and much of it is still off-budget. Lesotho's net official development assistance (ODA) flows over the 2017-2019 period averaged USD148.5 million per year.22 Moreover, the country ranks 27th in Sub-Saharan Africa according to the net ODA received as percentage of its GNI with 5.4% during 2019, while the region's aggregate (without high income countries) amounts to 3.2%.[11] The United States is the top donor for Lesotho which provided USD70.5 million during the 2018-19 period. The second donor is the International Development Association with USD38.4 million in the same period. Some 74% of ODA funds Lesotho received during 2018-19 are used for programmes related to health and population, while education is the second sector with 13% of funds received.[12]

On the 2020 Corruption Perception Index, Lesotho ranks the 83th out of 179 countries (11 out of 30 in Sub-Saharan Africa).[13] The country has embarked on several legal and institutional reforms in order to address different forms of illicit financial flows (IFFs) and reduce corruption and bribery in all forms across the country. Strengthening the independence and capacities of these institutions to perform their duties effectively and efficiently remains a major challenge and a priority.[14]

In recent years, Lesotho's economic performance has been negatively affected by slow global economic growth amid a major downturn in both emerging markets and advanced economies as well as natural disasters. Sustained political instability and the lack of a competitive private sector, coupled with slow economic growth in the South African economy, also contributed to slow economic performance. Real GDP growth rate is estimated to have contracted by 1.2% and 0.4% in 2018 and 2019, respectively and it is projected to average 0.6% between 2019–2023, largely attributed to the expected negative impact of the COVID-19 pandemic.[15]

The structure of Lesotho's economy has changed significantly from the one dominated by agriculture, real estate, and government services to the one dominated by manufacturing, retail and services. In the 1980s, agriculture was the most dominant sector contributing 15.2% to GDP. However, in recent years, the sector's GDP contribution has declined to 5.2% in 2017 (Figure 3). The sector remains critical for supporting the livelihoods of those living in rural areas, with more than 70% of households dependent on subsistence farming. Manufacturing of textiles and apparel became a dominant sector in the 1990s, driving growth and employment and exporting to countries such as the US, Belgium and South Africa[16]. Their contribution to GDP increased from 8.2% in 1984 to 23% in 2014. However, in recent years, Lesotho's textile industry has faced strong competition in the United States market from Asian producers. Its subsequent decline saw manufacturing's contribution to GDP fall from about 23% 2004 to 10% in 2014. The service sector

9 OECD, 'Aid at a Glance Charts - OECD', 2021, https://www.oecd.org/dac/financing-sustainable-development/development-finance-data/aid-at-a-glance.htm.
10 World Bank, 'Net ODA Received (% of GNI)', World Development Indicators | DataBank, 2021, https://databank.worldbank.org/reports.aspx?source=2&series=DT.ODA.ODAT.GN.ZS&country=MWI.
11 OECD, 'Aid at a Glance Charts - OECD'.
12 Transparency International, 'Corruption Perceptions Index 2020 for New Zealand', Transparency.org, 2020, https://www.transparency.org/en/cpi/2020.
13 Government of Lesotho, 'The Kingdom of Lesotho Voluntary National Review on the Implementation of the Agenda 2030 Report 2019'.
14 World Bank, 'Overview'.
15 Observatory of Economy Complexity, https://oec.world/en/profile/country/lso, viewed 18/2/22
16 Government of Lesotho, 'National Strategic Development Plan II 2018/19-2022-23'.

has also played an increasingly important role in Lesotho's growth, and this trend is expected to continue during implementation of NSDP II.[17]

Mining of diamonds in Lesotho is a growing activity, with the earliest commercial diamond mining in the country being traced back to the mid-20th Century. The industry experienced exponential growth in the first decade of the 21st Century when it went from having its contribution to the GDP being insignificant to a level where it accounted for approximately 7% of the GDP between 2013-17. While its diamond industry is not as large as in neighbouring Botswana, Lesotho's diamonds are among the largest in the world. The country's mines produced one of the largest diamonds in the world in 2018, a 910-carat diamond.[18]

The Global Competitiveness Index 2019 overview gives a snapshot of the challenges facing Lesotho in creating a competitive economy (Figure 4). According to the overview, the country needs improvements to foster the development of the private sector and promote efficient use of its limited resource. The areas that require most attention are the following:

- Infrastructure, to facilitate private investments by lowering production costs and opening new markets, thereby creating new production, trade, and profit opportunities;
- Financial system, since limited access to finance constrains private sector investment, particularly for micro, small, and medium sized enterprises. This is need is also evident in the prevalence of foreign companies establishing in the local market.
- ICT adoption, where only 15% of formal firms have a website and 45% use e-mail, which is much lower than the average for Sub-Saharan Africa. 31 Therefore, it is essential to support the development of digital literacy that is conducive for complex skills required by the industry such as the maintenance of industrial equipment.
- Market size, which requires to expand efforts from previous development plan to open foreign markets by developing trade agreements; and innovation capability, suggested by limited participation in the influx of technology hubs across Africa.[19]

From 2016 to 2020, Lesotho continued to register a negative trade balance, with USD662.3

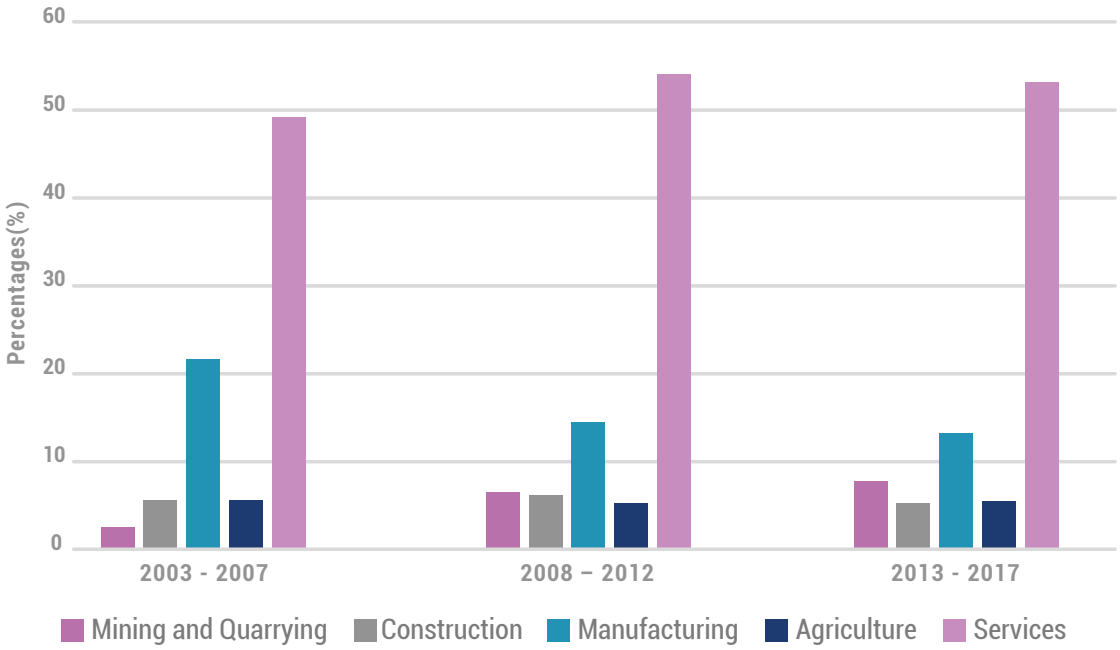


Figure 3. Contributions of sectors to the GDP. *Source: Government of Lesotho. 'National Strategic Development Plan II 2018/19-2022-23', n.d.*

17 World Atlas, 'What Are the Major Natural Resources of Lesotho?'
18 Anna Reva, 'Unlocking the Potential of Lesotho's Private Sector: A Focus on Apparel, Horticulture, and ICT', 2018, http://documents.worldbank.org/curated/en/832751537465818570/Unlocking-the-potential-of-Lesotho-s-private-sector-a-focus-on-apparel-horticulture-and-ICT.
19 Government of Lesotho, 'National Strategic Development Plan II 2018/19-2022-23'.

million during 2020. The main export items of Lesotho are textiles with approximately 53% of total exports, followed by diamonds with approximately 32% of total exports in 2020. The main export partners are South Africa (33%), Belgium (32%) and United States (29%). The import products in Lesotho are evenly distributed amongst a broad set of items. The main import items are textiles with approximately 14% of total imports in 2020, followed by machinery with approximately 10%, and mineral products with approximately 8%. The import partners are heavily concentrated with 79% of imports coming from South Africa (71%) and China (8%).[20] The import pattern shows that consumption in the country is dominated by products from foreign countries calling for increased productivity and added value from the local industry.

2.3 Education and Skills

In 2000, Lesotho had one of the highest literacy rates in sub-Saharan Africa at 86% of population aged 15 and over. However, the performance is declining (with 77% in 2014); but it is still above the sub-Saharan Africa rate of 63% and Least Developed Countries rate of 60%.[21] Primary education is free and compulsory for seven years for all children between ages 6 and 13. Secondary education is provided in two cycles of three years and two years, respectively. Primary and secondary schools remain largely administered by Christian churches, under the supervision of the Ministry of Education and Training. Postsecondary education is provided by the National University of Lesotho (1945) and Lesotho Agricultural College (1955), and there are also vocational and educational training centres in the country, including 17 Skills Training Centres and 20 Technical and Vocational Training Institutions.[22] [23]

Education remains one of the priority sectors of the government's spending. The highest share of the government's budget goes to the education sector, which is expected to receive 16.2% of that budget in 2020/21. However, the

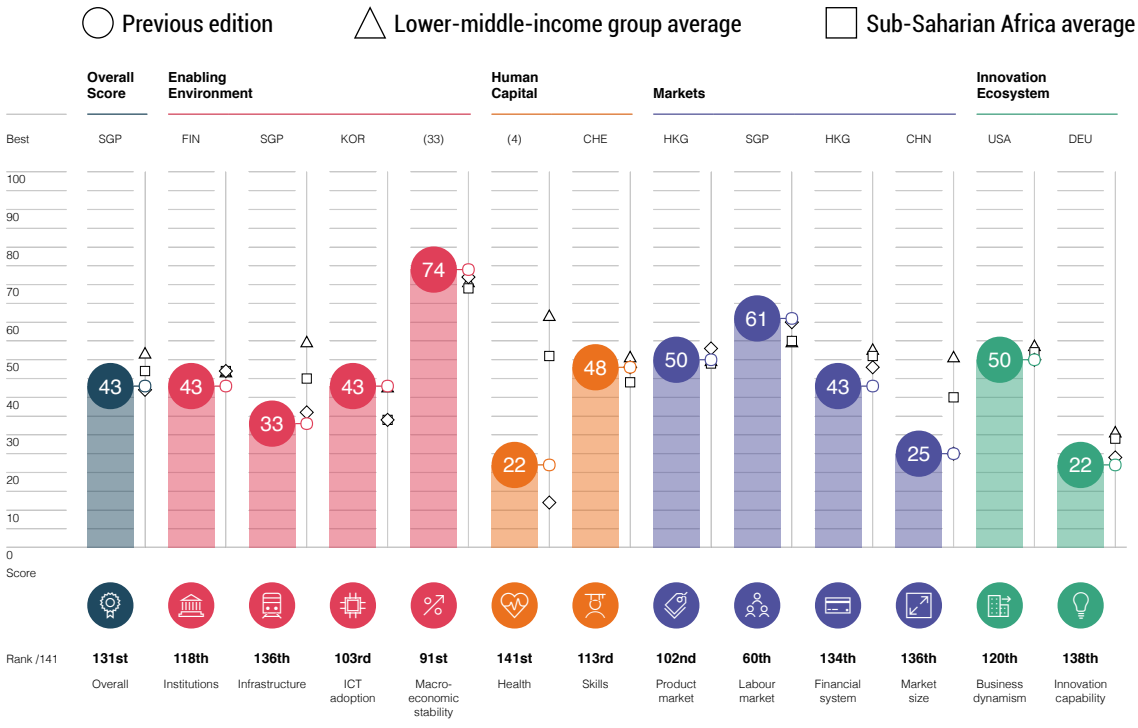


Figure 4. Lesotho's Global Competitive Index 2109 overview. *Source: WEF. 'The Global Competitiveness Report', 2019*

20 ITC, 'Trade Map - List of Products Commercialized by Lesotho', accessed 11 August 2021, https://www.trademap.org/Product_SelCountry_TS.aspx?nvpm=1%7c426%7c%7c%7c%7cTOTAL%7c%7c%7c2%7c1%7c1%7c3%7c2%7c1%7c1%7c1%7c1%7c1.

21 World Bank, 'Literacy Rate, Adult Total (% of People Ages 15 and above) - Lesotho, Least Developed Countries: UN Classification, Sub-Saharan Africa | Data', accessed 12 August 2021, https://data.worldbank.org/indicator/SE.ADT.LITR.ZS?end=2014&locations=LS-XL-ZG&most_recent_value_desc=true&start=1981

22 UNESCO, https://unevoc.unesco.org/home/Dynamic+TVET+Country+Profiles/country=LSO

23 Encyclopedia Britannica, 'Lesotho | Culture, History, & People | Britannica', accessed 10 August 2021, https://www.britannica.com/place/Lesotho.

proportion of Lesotho's expenditure to education remains second lowest in the Southern African Customs Union that comprises Swaziland (15.2%), Botswana (18.2%), South Africa (20.3%)and Namibia (22.1%).

As seen in Figure 5, basic and tertiary education receive the highest share of the education budget in Lesotho.

An important component of the tertiary education budget and consequently the overall education budget

are bursaries programmes to support all Lesotho's students, benefiting especially the poorest and most

marginalised. These bursaries contributed approximately the equivalent of 3.9 percentage points to the 16.2% budget share going to Lesotho's education sector. In comparison, the budget allocated for technical and vocational education and training (TVET) is very low at 0.86% for 2020/21 and decreasing from 1.41% in 2019/20.

The World Bank highlights that skills mismatches and lack of entrepreneurship programs for growthoriented businesses limit the competitiveness of Lesotho's private sector.[24]

The sectoral analysis also reveals that lack of specialised skills and skills mismatches are important constraints for the businesses. For example, no institution in the country offers training in sewing machine repair, which is a skill in high demand by the apparel industry; local universities do not offer degrees in horticulture (an industry prioritised by the government); and of the approximately 1,800 students enrolled at the National University of Lesotho, only about 40 majors in ICT-related courses. Furthermore, although several government ministries run entrepreneurship support programs, they do not address the needs of growth-oriented businesses.

2.4 COVID-19 impact

Lesotho remains vulnerable to the COVID–19 pandemic after emerging from a second wave of infections at the start of 2021. According to the World Bank, its real GDP is expected to contract by 5.3% in 2020 due to the impact of COVID-19, compared to an expansion of 0.4% that was expected before the pandemic. The pandemic has exacerbated Lesotho's weak macroeconomic performance and budgetary constraints leading to limited fiscal capacity to respond to shocks.[25]

While Lesotho launched a timely national response since the first cases of COVID-19 were identified in May 2020, it, similar to neighbouring countries, experienced a large resurgence of infections in the latter part of 2020, which accelerated from the end of December

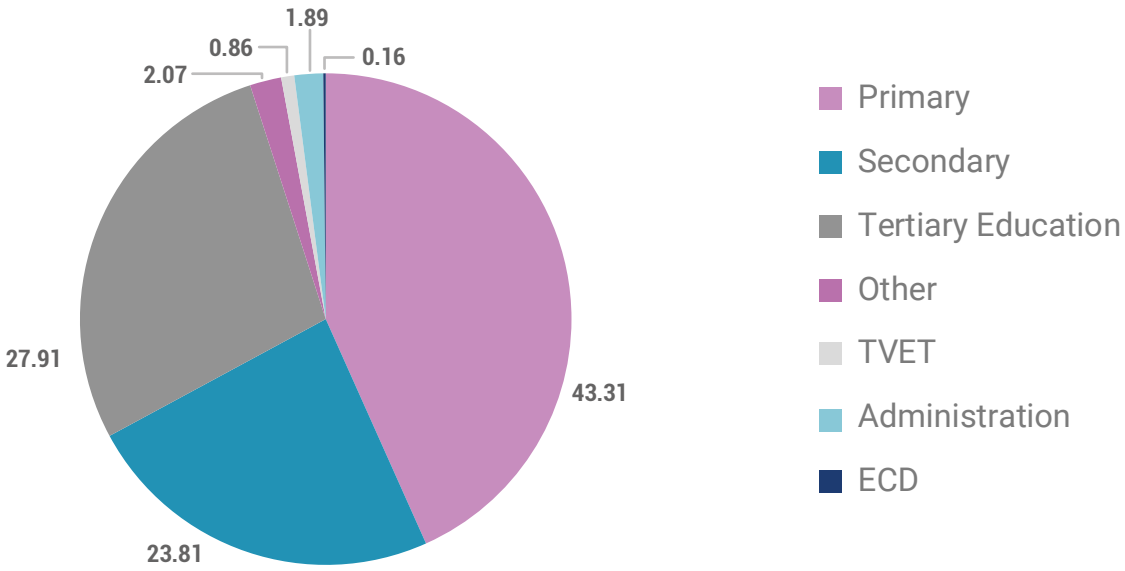


Figure 5. Global 'readiness' for frontier technology rankings. *Source: UNCTAD 2021.*

24 Reva, 'Unlocking the Potential of Lesotho's Private Sector: A Focus on Apparel, Horticulture, and ICT'.
25 https://www.worldbank.org/en/country/lesotho/overview#1

2020 and surpassed previous levels in the country. As of March 28, 2021, there have been 10,686 confirmed cases and 315 deaths as a result of COVID-19. It is evident that Lesotho, surrounded by South Africa, is affected by the evolution of the pandemic in South Africa, one of the most affected in the African continent.[26]

The pandemic is expected to lead to a significant increase in poverty and to a setback in human capital accumulation. While the human capital index increased from 0.34 in 2010 to 0.40 in 2020, Lesotho already fares below the average of lower middle-income countries and the situation has been exacerbated by COVID-19. In addition to the immediate impact of income losses, disruptions in essential health and education services are likely to reverse progress made in human capital accumulation and poverty alleviation thus far. The World Bank's macro-poverty outlook projections estimate that an additional 3.2% of the population has already been pushed into extreme poverty as a result of the pandemic, with the extreme poverty rate now estimated at 30.5%.[27]

The COVID-19 pandemic aggravates education poverty and inequality in Lesotho. Many children in the country are likely to experience learning deprivations due to the pandemic. To contribute to preventing exacerbation of education poverty and inequality, remote learning opportunities are required to be made available to all children who are currently without access.[28]

Figure 6 describes quantitively the response of Lesotho to the pandemic according to the Oxford COVID-19 Government Response Tracker. Lesotho's performance has been oscillating around the average of Sub- Saharan Africa (excluding high-income countries), mainly due to the introduction of debt/contract relief measures from April to September 2020. In January 2021, after reducing the number of measures and the number of cases increased above the Sub-Saharan Africa average, the country increased their response policies, mainly establishing more stringent international travel controls as well restrictions on gatherings.

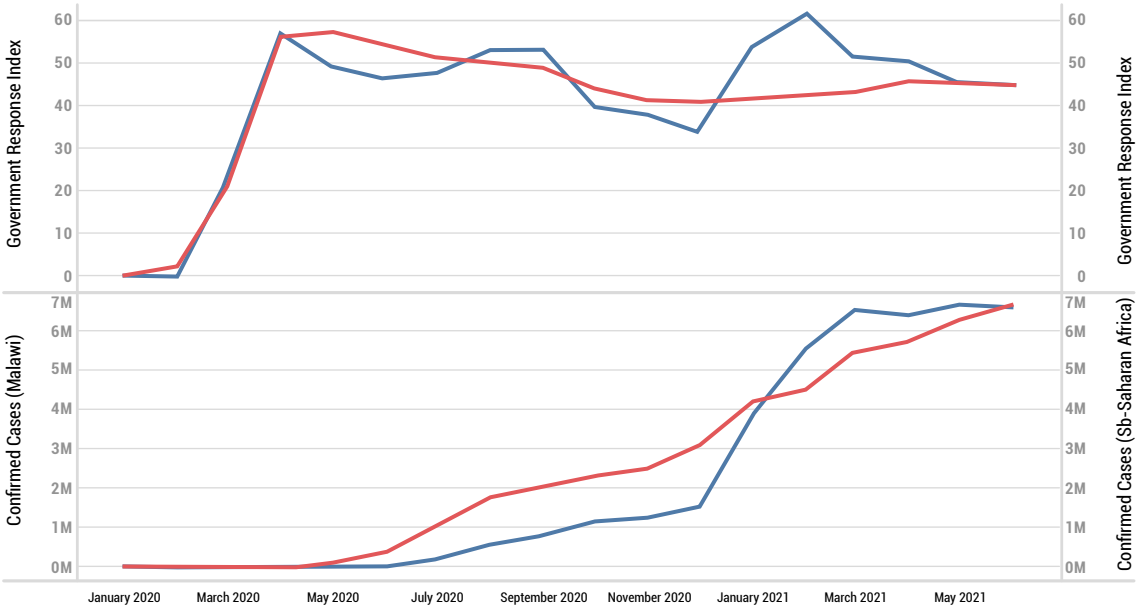


Figure 6. Government Response Index and Confirmed Cases. *Source: Hale, Thomas, Noam Angrist, Rafael Goldszmidt, Beatriz Kira, Anna Petherick, Toby Phillips, Samuel Webster, et al. 'A Global Panel Database of Pandemic Policies (Oxford COVID-19 Government Response Tracker)'. Nature Human Behaviour 5, no. 4 (April 2021): 529–38.*

26 World Bank.
27 World Bank.
28 UNICEF, 'Education Budget Brief Fiscal Year 2020/21', 2020, https://www.unicef.org/esa/media/8726/file/UNICEF-Lesotho-Education-Budget-Brief-2020-21.pdf.

CHAPTER 3
STI system and policy framework

3.1 STI Indicators

The latest R&D survey conducted in Lesotho was produced within the framework of an initiative of the New Partnership for Africa's Development (NEPAD) and covered R&D and Innovation for the reference year 2015.[1] There are no new R&D or innovation surveys publicly available as of July 2021.

3.1.1 R&D Expenditure

Lesotho's R&D Survey only covered the government and higher education sector; therefore, it is not possible to calculate the country's gross domestic expenditure on R&D (GERD). The government expenditure in R&D during 2015 was USD 0.44 million PPP which corresponds to 0.01% of the GDP. This is significantly lower than the 1% of GDP target set by the African Union[2]. These figures are the lowest amongst the countries surveyed in the Innovation Outlook III. Similarly, the higher education expenditure on R&D for the same period recorded USD2.96 million PPP, corresponding to 0.05% of GDP, ranking the country third from last amongst the countries surveyed.[3]

3.1.2 R&D personnel

As seen in Table 2, the majority of R&D personnel were researchers (69.4%), followed by technicians (17.6%). These figures imply that Lesotho would have in 2015 approximately 62 researchers per million inhabitants, a number much below critical mass estimation for the industrialised economy (i.e., 1000/1200 FTE researchers per million inhabitants[4]) and ranked 5th out of the six countries that have data in the Africa Innovation Outlook III for the Government and the Higher Education sector.[5]

Despite the need to still improve gender equality in R&D personnel (35%), Lesotho is second amongst 6 countries surveyed and women are mainly employed as researchers.[6]

The distribution of R&D personnel according to the level of education show that in 2015 the majority of researchers (52.8%) held master's or bachelor's degree while only 30.6% held PhD degrees. In terms of R&D personnel by field of science, the distribution of researchers is concentrated in the natural sciences with 49% and engineering and technology with 25% (Figure 7) leading the six countries with data from the government and higher education sector in the African Innovation Outlook III.

Table 2. R&D Personnel (FTE) in 2015

R&D Personnel		Researchers			Technician			Other Staff			Total		
Gender		M	F	Total	M	F	Total	M	F	Total	M	F	Total
Sector	Government	10	14	24	6	5	11	3	3	6	19	22	41
	Higher education	65	29	94	16	3	19	11	5	16	92	37	129
	Total	75	43	118	28	8	30	14	8	22	111	59	170

Source: AUDA-NEPAD. 'African Innovation Outlook III', 2019.

1 AUDA-NEPAD, 'African Innovation Outlook III', 2019, https://au.int/sites/default/files/documents/38122-doc-aio_3rd_edition_final_eng_repro.pdf.
2 UNESCO, 2020, http://uis.unesco.org/en/news/new-uis-data-sdg-9-5-research-and-development-rd, viewed 18/2/22.
3 AUDA-NEPAD.
4 UNESCO, Mapping Research and Innovation in the Republic of Rwanda, ed. G. A. Lemarchand; A. Tash, 2015.
5 AUDA-NEPAD, 'African Innovation Outlook III'.
6 AUDA-NEPAD.

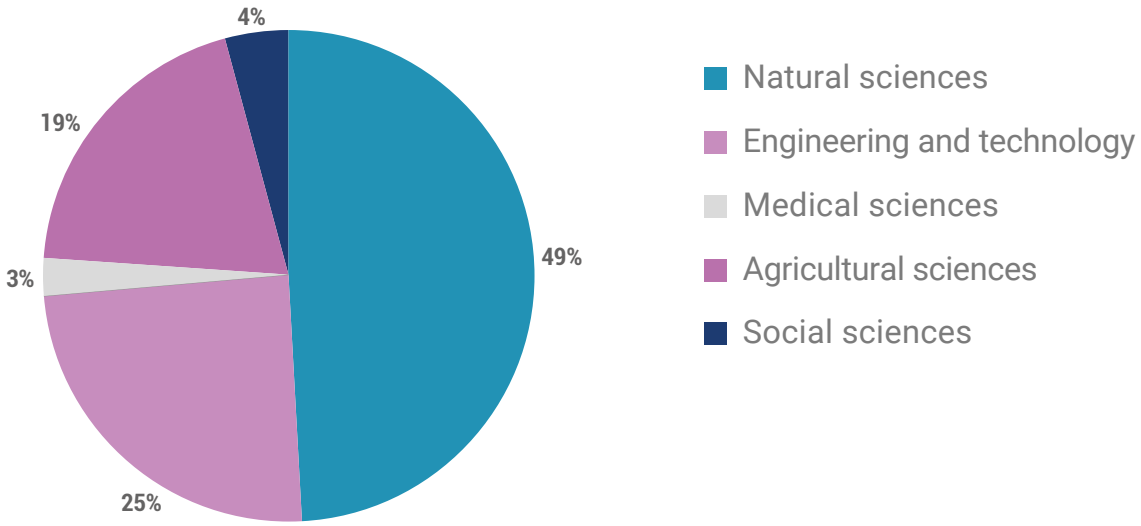


Figure 7. R&D personnel (FTE) by field of science/research and development in 2015. *Source: AUDA-NEPAD. 'African Innovation Outlook III', 2019.*

3.1.3 Scholarly works outputs

The bibliometric indicators are essential for assessing the R&D performance and specialisation of R&D performers of countries. As such, this section presents an overview of the scientific publication activity and the level of international co-operation in Lesotho.

As shown in Figure 8, Lesotho ranks last out of seven selected South African countries according to the total number of scientific publications between 2011 and 2019. Despite the low absolute numbers, the country doubled its scientific production during this period, achieving an overall total of 313 publications. Nevertheless, this figure is well below the median of Least Developed Countries (968 publications) and ranked 37th out of 48 amongst these countries.[7]

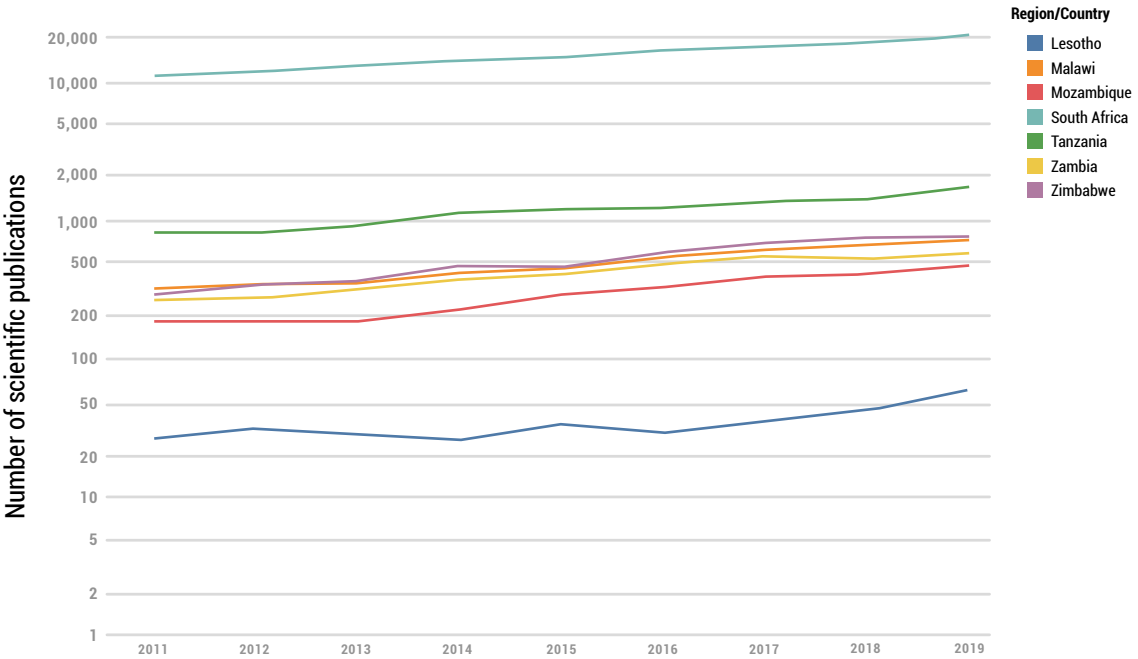


Figure 8. Number of scientific publications in selected South African Countries. *Source: AUDA-NEPAD. 'African Innovation Outlook III', 2019.*

7 UNESCO, UNESCO Science Report: The Race Against Time for Smarter Development, ed. S. Schneegans, T. Straza, and J. Lewis (Paris, 2021), https://unesdoc.unesco.org/ark:/48223/pf0000377433_eng.

Normalising by population Figure 9 illustrates a similar behaviour. However, Lesotho climbs one rank and places sixth above only to Mozambique. In 2019, Lesotho produced 28.2 publications per million inhabitants, slightly below the median of the Least Developed Countries (31 publications per million inhabitants).[8]

The publications patterns of the country remain stable along the years. Like in the majority of countries in the South Africa region, Lesotho publishes mainly in the health sciences field with 57.3% of publications during 2014-16 and 54.3% during 2017-2019 (Figure 10) where publications are highly concentrated. The second largest field of publication is environmental sciences with 10.4% during 2017-2019. Further review of the publication patterns in Lesotho indicated that out of three universities, only the University of Lesotho produced scientific publication indexed in international databases.[9]

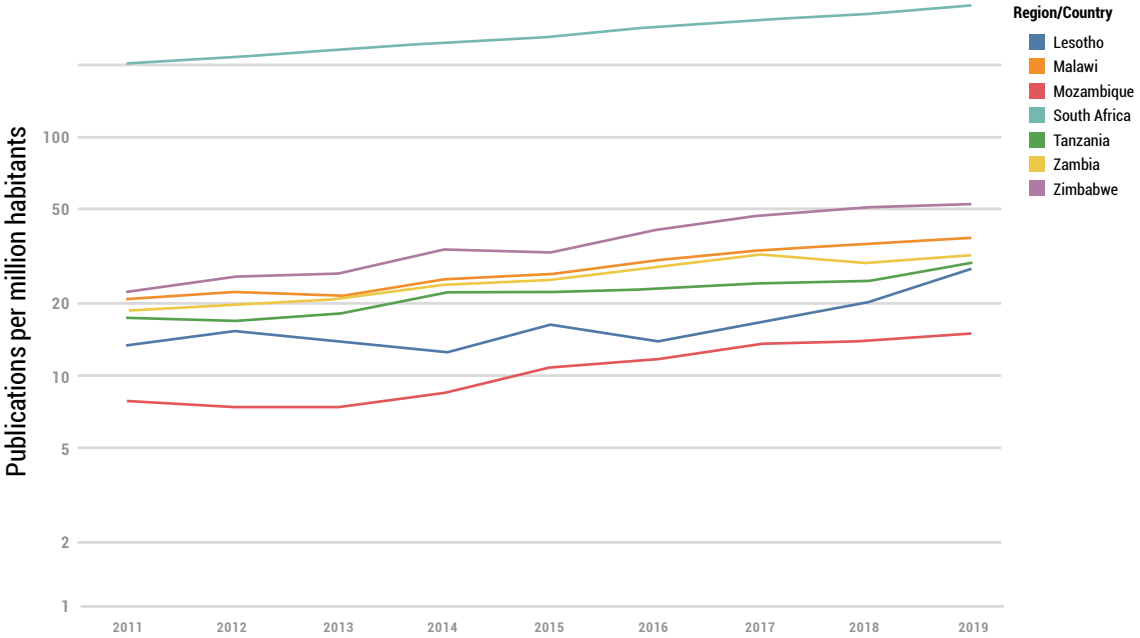


Figure 9. Publications per million habitants in selected South African Countries. *Source: UNESCO. UNESCO Science Report: The Race Against Time for Smarter Development. Edited by S. Schneegans, T Straza, and J. Lewis. Paris, 2021.*

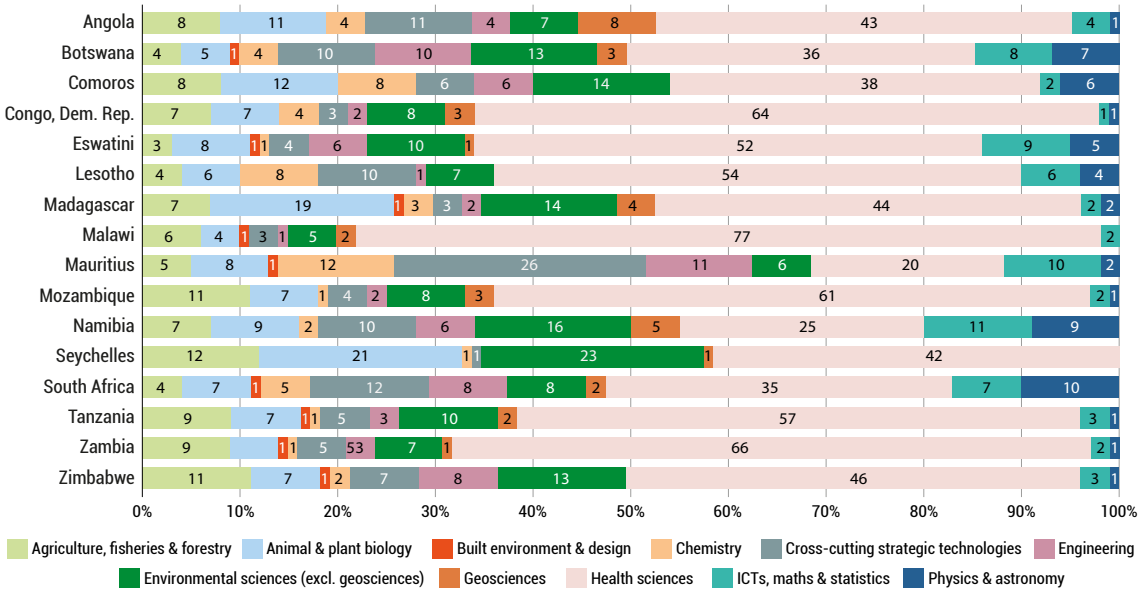


Figure 10. Share of scientific publications by field in selected South African Countries. *Source: UNESCO. UNESCO Science Report: The Race Against Time for Smarter Development. Edited by S. Schneegans, T Straza, and J. Lewis. Paris, 2021.*

8 UNESCO.
9 The Lens, 'Results The Lens - Free & Open Patent and Scholarly Search', The Lens - Free & Open Patent and Scholarly Search, 2021, https://www.lens.org/.

According to Figure 11, from 2011 to 2019, 84.8% of scientific publications in Lesotho have an international co-author. This is a common behaviour in Least Developed Countries where during the same period half of the countries produced at least 91% of publication with international co-authors. During 2017-19, the main partners of Lesotho were South Africa (47%), the US (40.2%), Switzerland (11.1%), Malawi (8.5%), Botswana (6.7%) and Uganda (6.7%).

3.1.4 Innovation

According to the African Innovation Outlook III, the number of firms surveyed in Lesotho was the smallest out of the cohort of countries analysed with only 36 firms. Out of these firms, 75% were categorised as innovative. Firms in Lesotho pursued more innovations in goods (44.4%) and processes (44.4%) than in services (30.6%).[10]

R&D is not prevalent in innovative firms in the country were only 48.2% preform R&D activities. Firms in Lesotho do not use intellectual property mechanisms. Only 19.4% of surveyed firms secured a patent in the country, 5.6% applied for a patent outside of Lesotho, 16.7% registered an industrial design, 36.1% registered a trademark, 30 % claimed copyright, and 13.9% granted a license for any type of intellectual property.[11]

3.2 STI system

The national STI system of Lesotho is at an early stage of development. The system is dominated by the public sector and remains unarticulated with weak connections between different stakeholders in the country. Lesotho is, therefore, in need of an oversight body to strengthen the linkages between industry, academia, government and the society. This body could also promote international collaboration which is currently limited due the perception of asymmetry of benefits received from the partnerships. The STI related roles are distributed across different ministries and other government agencies. An overview of the STI system is given below.

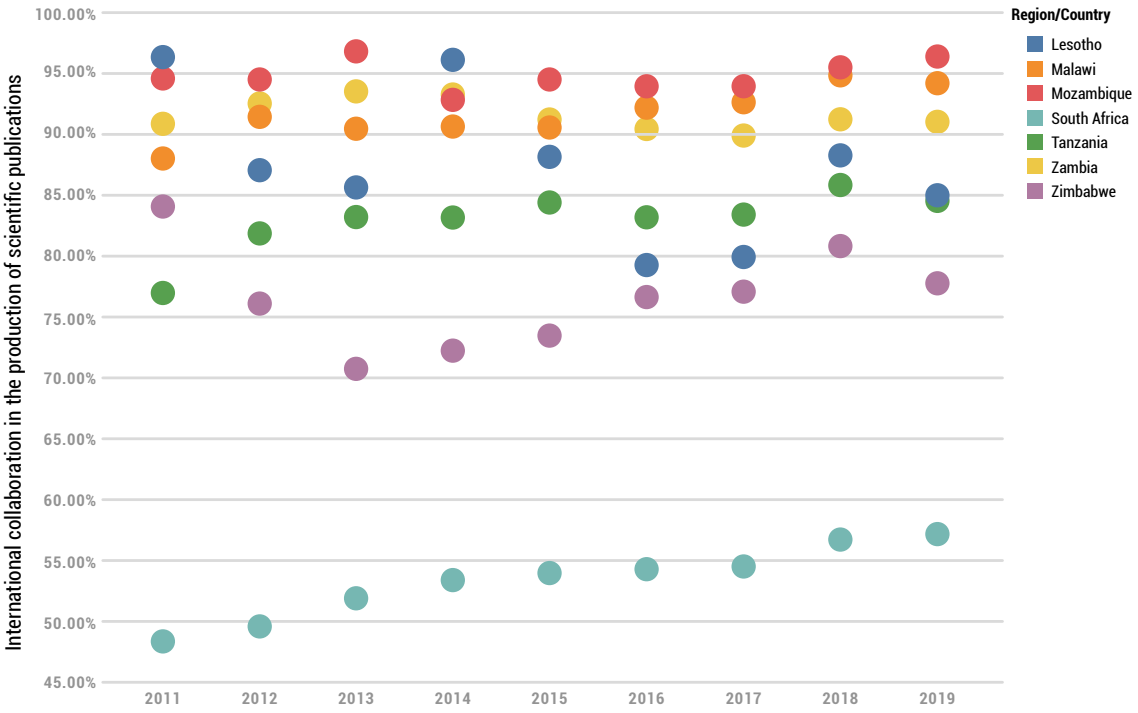


Figure 11. International collaboration in the production of scientific publications. *Source: UNESCO. UNESCO Science Report: The Race Against Time for Smarter Development. Edited by S. Schneegans, T Straza, and J. Lewis. Paris, 2021.*

10 AUDA-NEPAD, 'African Innovation Outlook III'.
11 AUDA-NEPAD.

3.2.1 STI policy-making

The organisations that are mainly involved in the policy-making in Lesotho are the following:

- The Ministry of Communications, Science and Technology has the mandate to coordinate science and technology development in Lesotho, and to oversee the evolution and operation of an effective S&T policy and a national innovation system. In line with this mandate, the Ministry will establish appropriate instruments to promote, motivate, guide, fund, facilitate and monitor S&T institutions, including new and on-going research programmes.[12]
- The Department of Science and Technology, established within the Ministry of Communications, Science and Technology, is mandated to formulate and implement policies and programmes that will promote growth of science and technology and create an enabling environment in which technological development will make meaningful contribution to the country.[13]
- Academy of Science and Technology, established in 2021 with the support of the UNTBLDC, is an independent organisation intended to strengthen science and engineering in Lesotho through government advice, networking promotion and supporting quality research.
- The Cabinet of the Kingdom of Lesotho is the executive branch of the government and made up of the Prime Minister and Ministers responsible for the different departments. Its main the overall decision-making process.
- Parliament of the Kingdom of Lesotho is the legislative branch of the government in charge of overseeing the legal and policy framework of the country.

The other key ministries responsible for promoting STI in key sectors also play a role in policy-making. These include the Ministry of Education and Training, Ministry of Industry, Trade and Marketing, Ministry of Agriculture and Food Security, Ministry of Development Planning, Ministry of Education and Training, Ministry of Energy and Meteorology, Ministry of Forestry and Land Reclamation, Ministry of Health, Ministry of Small Business Development, Co-operatives and Marketing, Ministry of Trade and Industry, Ministry of Transport and Ministry of Water Affairs.[14]

3.2.2 STI Policy implementation

At the operational level, a number of organisations are responsible for the actual performance of scientific research, technological development and innovation, as explained below.

- National Centre for Innovation & Research has the primary objective of conducting research, product innovation and science and technology advice.
- National University of Lesotho has the primary objective of teaching, research, material and product development. It is focused on providing management and science and technology skills, producing technical publications and advice, laboratory support, new materials and process innovations.
- Lerotholi Polytechnic has the primary objective to engage in process and product improvements activates, as well as training, extension activities and technical advice. Its contribution to this objective is focused on the provision of technical and vocational skills, producing technical publications and providing outreach services and appropriation of technologies.
- Limkokwing University is a private higher education institute with the main campus in Malaysia and presence in 8 other countries. The university's focus is on the development of skills at undergraduate level in the fields related to business and productive industry, as well as creative and ICT industries.

12 Government of Lesotho, 'Lesotho Science & Technology Policy 2006-2011', 2008, https://unesdoc.unesco.org/ark:/48223/pf0000158512_eng.
13 Government of Lesotho.
14 Government of Lesotho.

- Botho University is a private higher education institute established in Botswana with campuses in Eswatini, Lesotho and Namibia. The university's focus is on the development of skills at undergraduate level in the fields related to business, health and engineering.
- Ministry of Agriculture and Food Security has the objective of contributing to increase in on-farm productivity, better marketing facilities and higher value added to output and income. The focus of the ministry is to produce new processes, new products, uses, appropriate technologies and improve farm practices.
- Regional Innovation Centres have the objective of develop better uses of local plants, materials and indigenous skills and technologies.[15]

3.2.3 S&T services and infrastructure

The actors in this level represent a mixed group of organisations that support the undertaking of STI activities. The type of support can be in the form of a collection of STI data and information, testing, standardisation, metrology and quality control, activities related to patents and licenses, as well as the production of scientific publications. The main public actors include the following:

- Ministry of Education and Training has the objective of enhancing occupational skills as well as providing business, vocational and entrepreneurial training. The focus of the ministry is on the development of effective educational policy and programmes, certification, curricula as well as materials and methodologies.
- Appropriate Technology Services has the objective of increasing the rate of acquisition, use, transfer and popularisation of technologies for steady SME growth.
- Ministry of Tourism, Culture and Environment has the objective of managing the natural and environmental resources; science and technology and environmental information. The focus of the ministry at this task is to develop stronger domestic linkages, value added output, more trade and market intelligence information. Daily forecasts and recording of science and technology information, environmental impact and risk assessments.
- Lesotho National Development Corporation Operating under the general guidance of the Ministry of Trade and Industry, is the major parastatal organisation in the country charged with the responsibility for investment promotion and infrastructure development.
- Basotho Enterprise Development Corporation operates as a subsidiary of the Ministry of Trade and Industry. Its primary task is to promote and facilitate the development of local small and medium entrepreneurial activities across the country.
- Lesotho Communications Authority has the responsibility of developing the ICT sector in Lesotho, to provide universal service/access and a predictable, investor-friendly ICT regulatory framework for the country.
- The Bureau of Statistics is part of the Ministry of Development and Planning and provides statistical information and promote its use in policy formulation, decision-making, research, transparency and general public awareness.
- Lesotho Standards Institution established under the Ministry of Trade and Industry, provides standardisation and certification services to industry, government and the public.
- Department of Geological Survey Department acquires, updates, archives and disseminates all information on the geology and mineral resources of Lesotho in order to foster mineral resources development.
- The Lesotho Accelerator Lab created in partnership with the UNDP leads innovation and digital transformation through the "digital by default strategy". This ensures that support to the government of Lesotho to

15 Government of Lesotho; UNCTAD, 'Science, Technology and Innovation Policy Review of Lesotho', 2010, https://unctad.org/system/files/official-document/dtlstict20097_en.pdf.

bear minimum digital component as sensitisation measure to digital transformation.

3.3 STI Policies

With the support of UNESCO, Lesotho launched in 2008 an STI Policy for the years 2006-11.[16] In 2021, the Government of Lesotho embarked in the task of updating this policy. As of October 2021, the policy is still under development producing as intermediary output a Policy Recommendation Report (Box 1). The overall vision of the STI Policy of Lesotho 2006-11 is "A free, prosperous and progressive economy and society sustained through intelligent use of S&T assets by progressive and innovative citizens, corporations and government". In this context, the policy establishes the following long-term policy objectives:

- Develop a technologically competent and productive labour force (urban and rural).
- Create and apply a mix of technologies appropriate to Lesotho market needs.
- Generate and market high added value goods, services and meaningful job opportunities for Lesotho citizens and residents.
- Sustainably exploit Lesotho's resources and their comparative advantages, using information networks and alliances relevant to Lesotho citizens and enterprises' needs.
- Enable indigenous businesses to grow and expand jobs, employment opportunities and export earnings.

The policy defines as mission "to transform Lesotho into a modern state with a highly skilled, innovative and technically trained civil service, and a competitive S&T infrastructure supporting a growing and dynamic economy". In this context, the policy establishes the following specific strategic objectives:

- Enhance and foster a strong scientific and technological human resources base.
- Develop a culture of innovation for technological production.
- Promote employment creation and poverty alleviation through the use of science and technology initiatives consequently, enhance the quality of life of Basotho.
- Built a vibrant information society.
- Promote and commercialize indigenous knowledge systems.

The government of Lesotho, through its STI Policy, suggests sector-based approaches to integrate science and technology. Within this framework, the policy describes the role of STI in the sectors namely in education, culture and human resources; agriculture, land reclamation and food security; health, sanitation and population planning; environment, wildlife and tourism; meteorology; industry and commerce; water and sewage; energy; ICT; and transportation, construction and public infrastructure.

3.3.1 Policies related to supply side of STI

Supply side policies aim at supporting the development of capabilities of organisations directly performing STI activities. The main strategies outlined by the policy are:

- Sustain relevant, visible and accessible S&T programs of learning, practices and advocacy in technical, vocational and science-based disciplines.
- Accord high priority to S&T education, funding and research.
- Regularly appraise Lesotho's education system and budget and evolve a transparent formula for funding S&T training and research programs.
- Realise a consistent provision of critical S&T equipment, supplies, textbooks and journals to schools, colleges and research laboratories to encourage more S&T students and local interest in research.
- Undertake research and development in areas that affect the quality of life in Lesotho.
- Solicit core R&D funds to stimulate S&T

16 Government of Lesotho, 'Lesotho Science & Technology Policy 2006-2011'.

innovation in areas of national needs and priorities.

- Achieve fullest participation of women in S&T management, teaching, learning, research and development.
- Take initiatives on acquisition of knowledge and dissemination of information in compliance with the information and communication technology policy, geared towards building a strong knowledge driven economy.

3.3.2 Policies related to demand of STI

Demand side policies aim at increasing demand for STI creating bigger incentives for it, improving conditions for the uptake of innovations and to speed up the diffusion of new technologies. The main strategies outlined by the policy are the following:

- Increase in range, quality, value-added content and competitiveness in goods and services produced in Lesotho.
- Build up the science, technology and production culture in Lesotho through the establishment of nationally integrated science and technology parks, incorporating museums, libraries, and science centres.
- Develop and adopt appropriate technologies that will address the societal and economic needs of the nation.
- Enhance technology development, transfer and diffusion.

3.3.3 Policies to connect the supply and demand of STI

The main strategies outlined by the policy are:

- Develop and promote an efficient S&T support network and activities that will enhance the capacity of urban, rural, community-based entrepreneurs and SMEs.
- Provide, through S&T institutes, well-coordinated and cost-effective technical support to local entrepreneurs and enterprises to enhance local production and social marketing.
- Operate an effective S&T innovation system and network throughout Lesotho.
- Increasingly provide affordable access by entrepreneurs and local scientists to national, regional and global S&T information networks.
- Attain maximum synergy, cooperation and coordination between and among S&T users and R&D Institutions
- Identify and protect the Lesotho indigenous knowledge systems and convert them to innovative products and services that will benefit Basotho, as a niche area for competitive advantage in a global economy.

Lesotho implemented other sectoral policies that have concrete implications for the STI system. These are as follows:

- ICT policy for Lesotho (Date of Enactment: 2005): The policy has the mission of guiding the country to fully integrate information and communications technologies throughout all sectors of the economy in order to realise rapid, sustainable socio-economic development.
- National Climate Change Policy (Date of Enactment: 2017): The policy has the mission of increasing climate change resilience and improve the well-being of Basotho through mainstreaming and implementing concrete measures for adaptation and climate risk reduction, mitigation and low-carbon development, aiming at sustainable development, with active participation of all stakeholders in the social, environmental and economic sectors.
- National Trade Strategy (Date of enactment: 2020): The strategy's vision to "Export competitiveness for sustainable growth" will focus on three strategic objectives in the priority sectors of horticulture, textiles and garments and light industry: strengthening the competitiveness of the business ecosystem and improving trade facilitation; intensifying existing trade relationships and diversifying the range of export destinations; and expanding the national productive capacity and diversifying the export basket.[17]

17 ITC, 'Diversifying for New Markets: Lesotho's New Trade Strategy', accessed 14 August 2021, https://www.intracen.org/layouts/2coltemplate.aspx?pageid=47244640256&id=47244682448.

Box 1. Policy recommendation report 2021

The Policy Recommendation Report for the Research and Innovation Policy of Lesotho is the result of activities lead by the Department of Science and Technology, under the Ministry of Communications, Science and Technology, and supported by the Policy Support Facility programme of the Organisation of African, Caribbean and Pacific States which is funded by the European Union. The objective of the document is to assist policy makers to develop a national R&I policy by addressing specific challenges and identifying opportunities in the key thematic areas that require policy intervention.

The main recommendations produced by the report are:

Short-Term Recommendation (to start implementing within 1-2 years)

1. Establishment of a national Research and Innovation Agency. The national R&I Agency (RIA), reporting to Parliament through the Ministry responsible for Science, Technology, and Innovation, is recommended to provide a framework for guidance on R&I, undertake mobilisation of research resources and direct the nation's investments in R&I funding. The RIA shall support the local incubators and accelerator programmes at academic institutions and help innovative start-ups and MSMEs in Lesotho to build innovation capacity and take ideas to market. This shall be done through financial assistance, advisory services, and connections to the available business and R&D expertise.

Medium-Term Recommendations (to start implementing within 2-4 years)

2. Strengthening of Higher Education and Workforce Training Programmes. Government will improve the efficiency and effectiveness of workforce training systems to respond to the socioeconomic, cultural and development needs of Lesotho. Proposed programmes should improve the relevance of tertiary and higher education, address the skills mismatch, improve the quality of education and the overall global footprint of Basotho higher education institutions.
3. Prioritization of Investments in Collaborative Scientific Research and Development. Government will intensify investment in scientific research and development (R&D) and strengthen local innovation and technological capabilities. Proposed programmes should embed the need to develop and strengthen sustainable financing mechanisms, and as well improve effective collaboration between government, academia, industry, and society (Quadruple Helix Model of Innovation).
4. Improvement of Inclusion and Socio-economic Equality and Equity in R&I. Government will align and mainstream socio-economic equality and inclusion of all marginalized groups to improve participation of women, girls, herd boys, rural youth, disabled persons, and all other disadvantaged persons in STEM education, research, and occupations.
5. Integration of Indigenous Knowledge Systems and Management of Intellectual Property (IP) Protection. Government will mobilize indigenous knowledge systems (IKS) and grassroots innovations, nurture talent of ordinary and citizens outside of the education system and strengthen effective protection of intellectual property rights and enforcement mechanisms.
6. Creation of Conducive Business Environment for Innovation. Government will improve the regulatory environment (implement accessible incentives and innovative tax measures) in support of innovative start-ups and improve the performance of micro, small and medium enterprises (MSMEs) for employment creation.
7. Strengthening Access to R&I Information. Government will strengthen various institutions' ability to manage their own data, create an open data platform to make non-confidential R&I information easily available, share regular updates on R&I related activities and strengthen bottom-up job creation and economic growth.

Long-Term Recommendation (to start implementing within 4-6 years)

8. Adoption of New and Relevant Emerging Technologies. Government will support the adoption of technologies for emerging applications with strong focus on technical training to initiate a rapid transition to climate-resilient agriculture, quality healthcare, ICTs, manufacturing digitization and green economy.

The report also proposes as Results-Based Monitoring and Evaluation Framework, as well as potential Mechanisms for Financing the policy implementation.

Source: Government of Lesotho. 'Lesotho Research and Innovation Policy Recommendation Report'. 2021, forthcoming

CHAPTER 04
STI SWOT Analysis

4 STI SWOT Analysis

Based on the findings of desk and field research, including the focus group meetings with the stakeholders, an analysis of the STI-related strengths, weaknesses, opportunities and threats (SWOT) for Lesotho is given below. The summary of the SWOT is given in Table 3.

4.1 Strengths

- **National vision aligned with global and regional development agendas:** There is a clear vision for inclusive and sustainable development. The government is making a concerted effort to address the multivariate nature of development, taking a multisectoral approach to create a framework for integrating the SDGs, the AU Agenda 2063 and Southern Africa Development Community (SADC) Regional Indicative Strategic Development Plan.
- **Existence of key actors of the national STI system:** Lesotho is in the process of developing its STI system with the Ministry of Communications, Science and Technology playing a leading role. The ministry has the mandate of coordinating science and technology development in the country and is managing the process of developing a revamped STI policy.
- **Investment in research and knowledge development:** The National University of Lesotho is active in conducting scientific research that creates a knowledge base for socioeconomic development. Also, the accumulated knowledge in the agricultural sector can help boost production with the adoption of new technologies.
- **Broad indigenous and traditional knowledge:** Lesotho enjoys rich indigenous and traditional knowledge, especially in traditional medicine. The country has a large variety of medicinal plants some of which provide therapeutic alternatives that are farmer friendly, socially accepted, economically viable, environmentally sound and suited to the specific local conditions.
- **Existence of a young population with attitude towards innovation:** The high literacy rate of the country as well their attitude towards novelty is an important strength for technology adoption and development.

4.2 Weaknesses

- **Need to strengthen the STI governance:** Lesotho needs to establish a dynamic governance system and enhance coordination and collaboration between all actors in the STI system. The country will benefit from the creation of a high-level oversight body for the coordination of STI policy-making and implementation.
- **Need to create a national STI funding agency and provide sufficient resources to finance STI projects:** The absence of a dedicated national agency to design and implement support programmes and the lack of adequate funds to finance STI are major weaknesses prohibiting the accelerated sustainable development of the country.
- **Need to develop STI human resources:** There is a need to increase both the number and the qualifications of the human resources to create and maintain a critical mass of researchers and STEM graduates who can carry out research and innovation activities on an ongoing basis, and create and grow innovation-driven enterprises.
- **Need to create a balanced policy mix by designing direct and indirect STI policy instruments:** Lesotho requires to have a diverse set of STI policy instruments to encourage different groups of research and innovation performers to invest in STI and its commercialisation.
- **Need for intellectual property regulations:** An important barrier for technology development and commercialisation is the under-developed IPR system and legal framework. It also needs to incorporate the protection of indigenous and traditional knowledge.

- **Need to increase awareness and create a common understanding of STI among all stakeholders in the country:** There is a need to create awareness and common understanding of STI among different players of the STI system.
- **Need to expand and improve ICT infrastructure:** Lesotho needs improve the ICT infrastructure and provide uninterrupted internet connection. Increased investments are also needed to avoid disruptions to essential services such as health and sanitation.
- **Need to strengthen the support to SMEs and start-ups:** While programmes to support SMEs are becoming more available, access to loans and other sources of finance is an important challenge for start-ups.

4.3 Opportunities

- **Government's commitment to STI:** Recent developments on the STI policymaking and implementation offer opportunities to channel resources to the areas where needs are most urgent. The country would benefit from sufficiently funded policy instruments run by qualified teams that guarantee the sustainability of the policy direction.
- **Potential for niche agrobusiness:** Lesotho could diversify the agricultural production though niche products such as mushrooms, herbs or essential oils meeting the growing demand and improving the livelihood of the rural communities. A focus on producing niche products will also require adoption of new techniques and technologies to enhance productivity and competitiveness.
- **Investment in renewable energy:** Lesotho's objective to expand the electricity grid and further support off-grid solutions to serve rural areas present the opportunity to adopt solar energy technologies and develop skills and capacities and incentivise private sector participation. This opportunity is recognised in Lesotho's national planning documents; however, the country also needs to strengthen policy guidelines and regulatory framework that support the development of renewable energy.[1]
- **Mobilising skilled human capital available in diaspora:** Researchers, entrepreneurs and other highly skilled human resources from Lesotho living and working in other countries could actively participate in the STI-driven transformation of the country. Therefore, it is important to establish a dynamic network of diaspora and engage them in the STI-focused activities.
- **Greater use of ICT in the public sector:** Despite demand for digital services, information and communication technologies have inadequate interoperability limiting their use and productivity benefits.
- **Geographical proximity to South Africa:** Lesotho's location facilitates access to technologies and know-how available in its neighbouring country. It could promote knowledge transfer and spillovers through STI-focused strategic cooperation with South African technology-based enterprises and academia.

4.4 Threats

- **Adverse effects of climate change:** The economic activities in Lesotho are very vulnerable to climatic events such as decreasing rainfall and warmer temperatures, and the growing population and socio-economic development may exacerbate the country's vulnerability. Effective use of STI policy interventions and the use of appropriate technologies are essential to increase the capacity of the country to adapt to climate change and mitigate its impact.

1 The SREP Investment Plan for Lesotho notes that "a formal RE regulatory framework has not been adopted, the AfDB and EU are supporting an elaboration of the regulatory framework in the electricity sector." https://www.climateinvestmentfunds.org/sites/cif_enc/files/meeting-documents/srep_18_4_investment_plan_lesotho_final.pdf

- **Prioritisation of short term rather than medium-long term returns in STI investment:** There is a risk of choosing to invest in the areas with short-term returns rather than STI which has medium to long term returns. Additionally, the multiple strategic priorities in the country have the risk of diluting policy effectiveness.
- **Failure to appropriately align coordination and implementation of STI activities**: Ministry of Communication, Science and Technology's mandate is to develop and implement strategic and regulatory frameworks regarding STI activities, and in contrast, the ministry also implements services for both government and private sector entities. This makes the entire coordination process ineffective due to conflicting roles inherent within the ministry.
- **Limited competition in the broadband market:** Broadband internet access has been experiencing low uptake by businesses and consumers due to limited competition in the market that drives costs up and reduces network deployment.
- **Exodus of talented individuals:** Young and enthusiastic graduates and scientists leaving the country in search of more attractive opportunities abroad is common in Lesotho. Brain drain can hamper the development of priority sector and absorption of new technologies.

Table 3. STI SWOT analysis of Lesotho

Strengths	Weaknesses
• National vision aligned with global and regional development agendas • Existence of key actors of the national STI system • Investment in research and knowledge development • Broad indigenous and traditional knowledge • Existence of a young population with attitude towards innovation	• Need to strengthen the STI governance • Need to create a national STI funding agency and provide sufficient resources to finance STI projects • Need to develop STI human resources • Need to create a balanced policy mix by designing direct and indirect STI policy instruments • Need for intellectual property regulations • Need to increase awareness and create a common understanding of STI among all stakeholders in the country • Need to expand and improve national infrastructure • Need to strengthen the support to SMEs and start-ups
Opportunities	**Threats**
• Government's commitment to STI • Potential for niche agrobusiness • Investment in renewable energy • Mobilising skilled human capital available in diaspora • Extensive use of ICT in the public sector • Geographical proximity to South Africa	• Adverse effects of climate change • Prioritisation of short term rather than medium-long term returns in STI investment • Failure to appropriately align coordination and implementation of STI activities • Limited competition in the broadband market • Exodus of talented individuals

CHAPTER 5
Technology needs assessment

5 Technology needs assessment

The technology needs for Lesotho have been assessed through a three-step process (Figure 12). First, issues and technologies were identified for the following priority sectors by the national stakeholders: agriculture and food, conservation and environment, education, and arts, culture and heritage sector. These are listed below. Then, based on the needs and issues expressed by the stakeholders and identified in the secondary sources, the study team investigated available transferable technologies having the potential of highest positive impact (Section 6). The final input for the TNA was received from the stakeholders both during the focus group meetings and the validation workshop organised under the study.

As a result, a preliminary TNA implementation plan was prepared for the technologies that needs to be prioritised for Lesotho which also includes the responsible organisations as well as the estimated timing for the implementation of technology transfer and adoption (Section 7).

The issues and technologies needed for the priority sectors of Lesotho are given below based on the findings of the TNA survey completed by the national stakeholders.

Agriculture and Food Sector

The technology needs expressed in the TNA survey for the agriculture and food sector (farming, agro-processing, agro-forestry, poultry, fisheries and aquaculture., floriculture, health food, animal feed, apiculture, horticulture, dairy, food manufacturing, processing, and storage, etc.) are summarised below in Table 4.

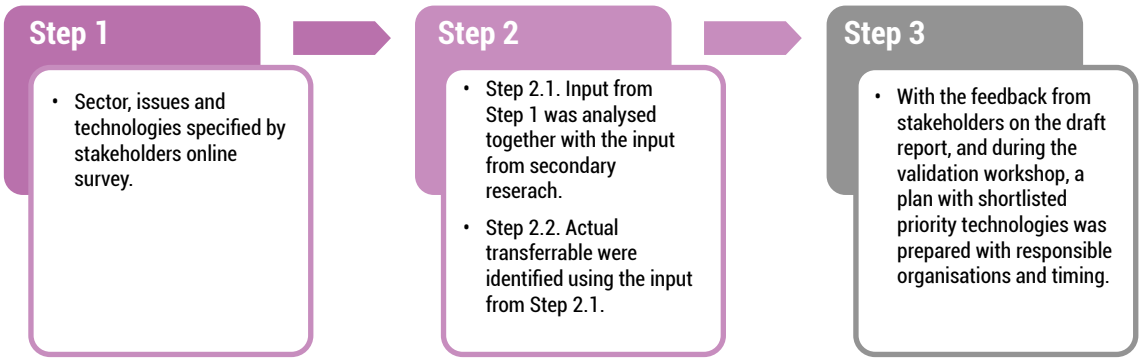


Figure 12. Technology needs assessment process.

Table 4. Technology needs expressed by the stakeholders for the agriculture and food sector

Issues	Responsible organisation	Technology needs	Expected Users	Capacity building needed
Many farmers involved in subsistence farming	Multi stakeholder: particularly the Ministry of Agriculture	Commercial farming, Urban Agric, vertical design farming	Farmers	Training and supply of advanced commercial farming technologies such as greenhouses, vertical farming
Decrease in yields	Ministry of Agriculture, Ministry of Science and Technology	Hybrid seeds and Genetic Modification	Farmers, retailers, manufacturers, innovation hubs	Legal framework, training on scientific researches and baseline studies
Climate Change affecting agricultural production	Ministries of Meteorology, Agriculture, UNDP	Drones' utilization, bee keeping	Farmers, manufacturer, innovation hubs	Training on environmental awareness
Farming is Labour intensive	Ministries of Science and Technology, Agriculture	Artificial Intelligence and Internet of Things: Automation of machinery	Farmers, innovators, manufacturer	Legal framework, training for science and technology

Issues	Responsible organisation	Technology needs	Expected Users	Capacity building needed
Environmental Degradation eroding fertile soils and Land Tenure	Ministries and stakeholders on aligned policies for proper Land Use and Environmental Protection/ Rehabilitation, Ministry of Communications Science and Technology	Smart irrigation technologies and skills development for organic farming	Farmers/public and Private Sector, Ministries	Training and Technology sourcing
Inadequate Research and Education and Capacity Building of farmers	Research Institutions, Ministries, Farmers, Private Sector and NGOS/CSOs, Ministry of Agriculture and that of Education, Ministry of Communications Science and Technology		Farmers and private sector, researchers	Training and Technology sourcing
Limited climate proven Technology	Ministry of Communications Science and Technology, Finance Ministry & Institutions, Research Institutions, TVETs, National Climate Change Policy implementations under LMS, Farmers and Basotho in general		Farmers, society, research institutions, ministries	Training and Technology sourcing
Weak and hard to implement Policy and weak of Coordination mechanism	All stakeholders Ministries/Private Sector/NGOs and society at large In coordination and alignment and implementation of policies, Ministry of Communications Science and Technology		Farmers, society, extension workers	Training of farmers and extension workers
Limited financial capacity to develop the sector	Ministry of Agriculture and food security, Development organizations		Farmers	Financial capacity building
Limited use of Renewable Energy to advance production	Ministry of Energy, NUL-ERC, Farmers, Ministry of Communications Science and Technology Private Sector, NGOs	Know-how and technical knowledge, skills development for organic farming and smart irrigation technologies	Farmers, society	Training and Technology sourcing
Limited expertise to support the sector	Ministry of Gender, Youth Sports and recreation	Water harvesting techniques	Higher learning institutions	Technical capacity building
Insufficient political support to the sector	Appropriate Technologies Services	Protected agriculture	Development partners	Financial support
Poor legal framework	Private sector	Agro-processing techniques	Non-Governmental Organizations	technical capacity building
Inadequate appropriate technologies	Ministry of Agriculture and food security	Digital and financial solutions	Government Ministries	Exposure to digital technologies

Conservation and Environment

The technology needs expressed in the TNA survey for the conservation and environment (wildlife, land, water and forestry management, water and air quality, waste management, pollution control, etc.) are given in the following table 5.

Table 5. Technology needs expressed by the stakeholders for conversation and environment

Issues	Responsible organisation	Technology needs	Expected Users	Capacity building needed
Water resources data collection, management and dissemination is a challenge	Department of Water Affairs	• Online water quality measuring devices • Online water quantity measuring devices • Water resources database software • Water resources models	Department of Water Affairs	• Data collection, storage validation and analysis • Calibration & maintenance of equipment • Software updates • Water resources modelling
Limited online water resources monitoring gadgets	Commissioner of Water			

Education

The technologies needed for education sector (STEM, TVET, higher education, virtual/distance education, etc.) is given in the following table.

Table 6. Technology needs expressed by the stakeholders for the education sector

Issues	Responsible organisation	Technology needs	Expected Users	Capacity building needed
Limited access to internet by student due to high data cost	Lesotho Communication LCA is assisting, but otherwise it is the responsibility of the College Authority	• Data subsidy • Wi-Fi • Computers • Smart phones	Students	
Limited technological materials for teaching	Government and Institutions of Higher Learning Econet		Teachers	
			Teachers	
Limited Infrastructural facilities that enable digitalization of higher education	Government and Institutions of Higher Learning	User friendly and interactive teaching and learning platforms e.g. blackboard etc	Teaching staff and students	Training
Technological divide in higher education institutions	Government and Institutions of Higher Learning	provision of enabling technological facilities for all institutions of higher learning	Teaching staff and students and community	Training
Limited technological expertise in the higher education sub-sector	Institutions of higher learning	Training in digital skills and their application for academic professionals to improve efficiency and communication.	Teaching staff and students	
Non-existence of clear sectoral strategy that drives innovation and technology in higher education	Government through the Ministry of Education tertiary sector	Development of a higher education technology strategy that will drive achievement of set goals	All higher education key stakeholders	

Issues	Responsible organisation	Technology needs	Expected Users	Capacity building needed
Limited access to ICT gadgets: computers/ laptops etc.	The academic institution _ Lesotho College of Education for our case	Provision of laptops for staff; development of ICT policies for students	Teaching staff and students	Continuing training of staff and students on the use of the gadgets and development of ICT policies
Limited access to Integrated online data management systems and/or learning management systems by staff and students	The academic institution _ Lesotho College of Education	Integrated data management systems and LMS	Teaching staff and students	Training of staff on the use of the systems
Inadequate training on use of online teaching and learning	The academic institution _ Lesotho College of Education	Skills development for lecturers; establishment of coordinating offices for staff training	Staff and students	Training of staff on online content development
Insufficient software and techniques for running examinations online	The academic institution _ Lesotho College of Education	Online examination monitoring software; skills development for lectures to set credible online examination	Staff and students	Training of staff
Weak linkages between education/ Training and Job Markets	Council on Higher Education	Availability of low-cost assistive devices for information technologies by learning institutions that provide job market requirements	Basic and Higher education learners and technical and vocational trainees	
Educational programmes and qualification not socially responsive	National Manpower Development Secretariat	Availability of low-cost assistive devices for information technologies by learners and learning institutions	General public and scholars	
Limited use of technology as a vehicle for access to education	National Communications Authority & Ministry of Planning	Technical skills for educators in the usage of educational technologies	Teachers and trainers	
Limited private sector participation in education and training	Lesotho Revenue Authority and Ministry of Education and Training	Greater availability of broadcast technologies as learning platforms	Basic education learners and out-of-school adult learners	
Reduced public and household spending on education and training	Treasury, Ministry of Education of Education and Training	Integrated information management technologies across public and private sector players	Private Sector and public sector institution that provide social services to the public	
Limited access to internet	Camara/ MoET, Econet Telecom Lesotho, Vodacom,LCA,USF,LCA	Rural connectivity	Teachers, students and communities	
Digital Literacy is inadequate	Vodacom	Digital Literacy (Teacher Training)	Teachers, students and communities	Training
Education content not aligned to local context	Ministry of Education and Training (NCDC)	Digital platform where new material can regularly and continuously be updated and shared across the relevant parts of the education system.	Teachers, students and communities	Training

Arts, Culture and Heritage

The technologies needs expressed by the stakeholders for arts, culture and heritage (indigenous knowledge systems and innovation, marketing and promotion of the creative industries, develop collective management system, branding and classification, promotion of heritage sites and their management) are given in the following table.

Table 7. Technology needs expressed by the stakeholders for the arts, culture and heritage sector

Technology needs	Responsible organisation	Expected Users	Capacity building needed
Software for upgrading database for heritage sites, artists and artisans	Ministry of Trade and Industry, Bedco and Ministry of Tourism Environment and Culture	Archaeologists, palaeontologists, conservators, heritage sites managers, museum and art galleries, department of culture officers	Capacity building on the use of IT
Mobile expo cubicles/ creative expo booths, technical machinery such as weaving loom machine for mohair products, machinery for jewellery and leather products), film and music camera and sound equipment with laptops and microphones, editing suit, zero rate data, lighting systems and theatre moving lights	Ministry of Law and Constitutional Affairs, Lesotho Mounted Police Services, Lesotho Revenue Authority, judiciary, Prosecution and GoL Departments	Artists and artisans (film, music, drama and theatre, crafts etc.)	Capacity building on the use of equipment
Drones with cameras and GPS for documentation and monitoring of the heritage sites	Ministry of Trade and Industry, Ministry of Tourism, Environment and Culture	Archaeologists, palaeontologists, conservators, heritage sites managers, museum and art galleries, department of culture officers	Skills development on IT and documentation of heritage resources
Development of department of Culture website, Mobile application for documentation of arts, culture and heritage resources sites	Ministry of Tourism Environment and Culture, Lesotho Tourism Development Cooperation	Department of Culture	Skills development on IT and graphic design

CHAPTER 6
Transferable technologies to address priority needs

6 Transferable technologies to address priority needs

The available transferable technologies identified by the study team through a comprehensive research based on the priority needs of the country are given in the following table.

Table 8. Transferable technologies to address priority needs

Sector	SDG	Technology	Description	Potential suppliers	Links (if available)
Agriculture	2	Affordable Machinery	Using "scale-appropriate" machinery from planting to harvesting. (e.g., Walking tractors with replaceable attachments, such as plough, seeder/ planter etc.)	Various	Examples walkingtractors.co.ke www.honest-industrial.com www.bcsagri.it
Agriculture	2	Agricultural Productivity	A digital platform providing information, as well as interactive solutions needed to increase productivity such as: • Weather forecast • Pest alerts • Seed exchange • Remote / on-line trainings • Agro-input market (e-commerce platform for non-tool inputs such as fertilizers, pesticides etc.) • Tool, equipment and machinery platform (renting machinery, buying/selling/ exchanging tools and equipment etc.)	Various	Examples: prise.org hellotractor.com aquaponics.africa
Agriculture	2	Agricultural Productivity	A mobile B2B platform connecting farmers with retail market actors	Twiga (Kenya)	twiga.com
Agriculture	2	Aquaponics	Aquaponics is a food production system that couples aquaculture (raising aquatic animals such as fish, crayfish, snails or prawns in tanks) with hydroponics (cultivating plants in water) whereby the nutrient rich aquaculture water is fed to hydroponic grown plant, involving nitrifying bacteria for converting ammonia into nitrates (Wikipedia)	Ichtys Aquaphonics (as an example. It is a large aquaponics hub in South Africa, providing trainings to starters as well)	aquaponics.africa
Agriculture	2	Bee Vectoring	The technology uses a naturally occurring fungus called BVT-CR7, or Vectorite, that helps protect crops from a variety of diseases. The Vectorite solution is placed inside a hive of commercially raised bees and the bees collect the solution whenever they exit the hive. The solution is then distributed by the bees to the surrounding crops and fields. No pesticides and no water needed.	BVT (Canada)	beevt.com/solution/hive-bees-bee-vectoring-technology

Sector	SDG	Technology	Description	Potential suppliers	Links (if available)
Agriculture	2	Integrated Farming	Integrating crop production with livestock management and/or fisheries (in some cases forestry) which in a way complement each other with a symbiotic relationship which at the time is economically viable and profitable, environmentally suitable, and benefit giver of diversification of production.	Various individual technologies can be used together to increase efficiency. It is an approach, rather than being a turn-key solution.	sciencedirect.com/science/article/abs/pii/S0959652617323569 ars.els-cdn.com/content/image/1-s2.0-S0959652617323569-fx1_lrg.jpg www.fao.org/3/y5098e/y5098e.pdf www.songhai.org/index.php/en/home-en/16-songhai/189-bioproduction-en
Agriculture	2	Precision Agriculture, Agro-Monitoring	Monitor crops, farms, fields with drones, UAVs (Unmanned Aerial Vehicles), satellites and collect data to increase production by using lesser resource, decrease chemical, synthetic pesticide usage, etc.	AgEagle (USA) Precision Hawk (USA) Gamaya (Switzerland, Brazil) TaniBox (Estonia)	ageagle.com/agriculture www.precisionhawk.com www.gamaya.com www.tanibox.com
Agriculture	2	Precision Livestock Production	Using ICT and AI to observe nutritional, behavioural, health and environmental activities that can impact production	Cainthus (Ireland, USA) Rex Animal Health (USA)	www.cainthus.com rexanimalhealth.com
Agriculture / Fisheries	2	Carbon Transformation	All-natural microbes are used to transform CO2 and other gases into high-valued nutrients, oils, and bio-based products. The platform, which extends early NASA research, converts carbon dioxide from diverse industrial and agricultural sources into new materials using proprietary gas fermenting microbes.	Kiverdi (USA)	www.kiverdi.com
Agriculture / Forestry	2,15	Seed ball shooting	Delivering airborne seed ball shoots by drones in areas that need to be afforested	Ecording (Turkey) BioCarbon Engineering (UK)	ecording.org/en/ecodrone www.biocarbonengineering.com
Education	4	e-learning distribution platform for NGOs	A mobile platform that helps NGOs to prepare and publish e-training content. Both training providers and beneficiaries (not only students, but farmers, life-long learners etc.) register the appropriate program and launch the content. Evaluation and other tracking features help NGOs monitor the performance of their programs. Downloadable content makes it available offline.	Chalkboard Education (Ghana)	www.chalkboard.education
Education	4	Affordable equipment for online / distant learning	To connect mobile network and to access wide range of learning resources, tablets are better than mobile phones. Affordable tablets with bundled apps and supporting equipment would provide an efficient platform.	School in a Box (a non-profit organisation founded in South Africa for K-12 students)	schoolinabox.co.za

Sector	SDG	Technology	Description	Potential suppliers	Links (if available)
Education	4	AR & VR in Education	Using Augmented Reality (AR) and Virtual Reality as a supporting interactive tool. AR can be used in tablets and mobile phones.		
Education	4	e-learning content	New e-learning methods to improve student's basic math and science skills for further STEM education. Mobile apps with interactive videos/games provide such content	Many. As an example, eLumi (Kenya) aims to provide such an environment all over Africa, involving teachers, primary school students and parents. Green Shoots (South Africa) connects ICT with educations and uses a cloud-based Moodle platform to implement an online Maths Curriculum for South African grades 3-9 (ages 8 -15).	e-limu.org www.greenshootsedu.co.za
Education	4	Inclusive Online Education	Adding parents as a part of online education together with students and teachers	As an example: Edmodo (USA)	go.edmodo.com/distancelearning
Education	4	Supporting higher education	Joint programs run by universities in developed countries with higher education students in LDCs with a combined curriculum of in-person and online courses.	As an example: Kepler is an NGO working in Rwanda, in partnership with Southern New Hampshire University. SNHU provides students with access to accredited American degrees through competency-based online degree. It has two centres in Rwanda.	

Sector	SDG	Technology	Description	Potential suppliers	Links (if available)
Education	4	Supporting teachers for e-learning and distance education	Improving digital skills of teachers to better adopt on-line / remote education, as well as delivering professional materials and soft resources to them.	International Youth Foundation (USA) provides free online learning resources for educators and students during COVID-19. The Dr. C.L. Smith Foundation (South Africa) aims to improve the capacity of teachers on a digital platform (zibuza.net) Instill Education (South Africa) developed a mobile platform for training teachers on online-education with practical content	iyfglobal.org zibuza.net instill.education
Energy		Pyrolysis	Pyrolysis is thermal degradation either in the complete absence of oxidizing agent, or with such a limited supply that gasification does not occur to an appreciable extent or may be described as partial gasification. Pyrolysis has been practised for centuries for production of charcoal. Today with biomass pyrolysis, solid biomass and wastes which are very difficult and costly to manage can be readily converted into liquid products. These liquids, as crude bio-oil or slurry of charcoal of water or oil, have advantages in transport, storage, combustion, retrofitting and flexibility in production and marketing.	Enoven (Turkey)	enoven.com.tr

Sector	SDG	Technology	Description	Potential suppliers	Links (if available)
Energy	7		Microgrid technology is a decentralized version of the massive electrical grids that exist in most developed nations. More definitively, a microgrid is "a local energy grid with control capability" that can work autonomously to both produce and supply power to small communities. The autonomy of microgrids limits the negative aspects of larger power grids, such as rolling blackouts. Most popular approach is using solar power as the primary energy source. There are applications in African countries such as, Kenya, Tanzania, Sierra Leone, Nigeria.	PowerGen (Kenya, Tanzania, Sierra Leone, Nigeria) Energicity (Ghana, with subsidiaries in West African countries) TesVolt (Germany)	powergen-renewable-energy.com energicitycorp.com tesvolt.com/en/applications/micro-grid.html
Energy	7	Solar Energy	Portable, in-house solar power solutions. Consists of PV panel and a battery unit. Ready to feed electronic equipment for daily use. Several purchasing methods are available. As an example: An initial payment is made at purchase. Depending on the equipment and initial payment, annual or two-year plan is applied. Customer pays a certain amount of monthly fee (added to GSM bills). At the end of the plan, customer becomes the owner of the system.	There are several companies in operating in Africa, such as: Lumos Global (Netherlands) Barefoot Power (founded in Australia, bought by African subsidiaries. Operates in Kenya)	lumos-global.com barefootpower.com/index.html
Energy	2, 13, 15	Combustion Rocket Stove for Cooking	Rocket Stove design is based on a dual combustion process where wood gas and smoke is drawn into a secondary combustion chamber which burns the smoke and releases an abundance of additional heat. With the product, it is aimed to use less wood and contribute to the protection of forests, as well as preventing air pollution with %90 less smoke emission.	Himalayan Rocket Stove (produced in India, already available in Nepal and Bhutan)	himalayanrocketstove.com/product/ecomini-rocket-stove
Energy, Agriculture	2, 7	Underground Cooling	A barrel like container is dug in and covered with the excavated soil from its new location. Temperature within the container barely varies. Furthermore, it is fitted with a battery-driven ventilator for fresh air, which is used one hour a day.	GroundFridge (Netherlands)	groundfridge.com/groundfridge/installation

Sector	SDG	Technology	Description	Potential suppliers	Links (if available)
Energy, Waste Management	2, 15	Biogas Digesters	Slurry-Separation Technology (SST) used in biodigesters tackles waste management at the source, generates alternative energy known as biofuel, and provide independence from water demands. It aims to reduce the reliance on non-sustainable biomass and mitigate deforestation. Biodigesters are installed in Uganda, Mozambique, Togo, Ethiopia and Haiti.	Green Heat (Uganda)	greenheatinternational.com/biogas
Forestry	15	Boosting reforestation by biomimicry	Device that mimics leaf litter by keeping soil from intact and moist, and protecting newly planted trees against predators. It helps surviving the seedling phase of trees with minimum maintenance requirements, therefore boost reforestation of fields	Nucleário (Brasil)	nucleario.com
Forestry	15	Prevent illegal logging	A network of old mobile phones are installed in appropriate locations in a forest with small solar-panels as power generators. Sound in / of the forest is monitored in real-time with an intelligent software analysing the collected data. Any sound matching the operation of a chainsaw or other tool / machinery generates an alarm with location coordinates.	Rainforest Connection (USA)	rfcx.org
Forestry	15	Real-time monitoring	Global Forest Watch is a project that monitors forest areas via satellite imagery all over the world in real time and shares the data as an open-source material for free. Similarly, FAO offers an open-source cloud-based platform allowing countries to access their data.		globalforestwatch.org sepal.io
Forestry	15	Real-time monitoring	With the help if IoT and Cloud technologies, forest are monitored in real-time. Devices equipped with several sensors are attached to trees. They provide various data including humidity, temperature, disturbance in forest areas to the cloud. Authorities are warned in unusual cases and they can use the data for tracking the forests.		orfonline.org/research/modern-technology-for-sustainable-forest-management-in-india

Sector	SDG	Technology	Description	Potential suppliers	Links (if available)
Health		Oxygen Generation	A set of interconnected medical oxygen generators, will allow each hospital to produce its own oxygen. Each station is connected to electricity and Produces 93% pure oxygen from the natural air. The station has a battery plus a solar panel and is 3G-enabled granting the users and operators the ability To monitor it effectively, even remotely by using mobile phones.	Oxynnet by Arthur Zang (Cameroon)	prosygma-cm.com/index.php/en/news/cameroon-coronavirus-arthur-zang-designs-the-oxynnet-system-to-help-hospitals-produce-medical-oxygen
Health	3	Pandemic Awareness	Raising awareness for COVID-19 among the society with mobile apps. Several solutions are available varying in a large spectrum from chatbots and specialist reviews to personal assistants for handicapped individuals (with special features including sign language, voice recordings, info about prevention, symptoms and personal care etc.)	Various apps developed by entrepreneurs, especially in Africa (e.g. Eritrea, Kenya, Zimbabwe)	https://play.google.com/store/apps/details?id=org.undp.er.health&hl=tr&gl=US ("Eritrea tackling COVID-19" mobile app for Android phones) https://play.google.com/store/apps/details?id=com.dencroft.covidapp&hl=en&gl=US ("ZimCovid Safe" mobile app for Android phones)
Health	3	Portable medication against aerial bacteria and viruses, including SARS-COV-2	RESP301 is a nitric oxide (NO) generating medication that the patient inhales from a simple hand-held nebuliser. The fine particle droplets release NO into the lungs and upper airways. NO is produced normally in healthy lungs and is the first line of defence against viral or bacterial infection. RESP301 replenishes the NO and helps boost the body's immune system. A huge advantage of the NO produced by RESP301 is that it remains effective even against the new variants of the virus.	30 Technology (UK)	https://30.technology/approval-post-exposure-clinical-trial-covid-19/
Health	3	Self-test	Works with a mobile app and a specially designed "strip-like" kit. The strip has a colour matrix on it. It is dipped in fresh urine sample, and left there for two minutes. After that, the strip is scanned by the app via the camera of the mobile phone. Discolorations on the colour matrix is analysed by the app, and urine test results are shown. It can be shared with a doctor and stored to keep track of the individual's health conditions	AssayMe (USA)	https://assayme.cc/

Sector	SDG	Technology	Description	Potential suppliers	Links (if available)
Health	3	Telehealth / Telemedicine	Video-consulting or virtual-visits provide patients to reach physicians for remotely diagnosable conditions such as allergy, rash, cold/flu symptoms, local pains and aches, minor cuts and burns etc. In addition, prescriptions are sent to local pharmacies. In some cases, patients can consult to psychiatrists and neurologists (when they suspect that they are having a stroke). A mobile app is downloaded to their phones, and after a one-time registration process, they can choose their physician and start the session. Can be used as a pro-active tool for COVID-19	Many health care facilities in several countries provide this service. Similar service is provided by a Swedish start-up (GLOBAL PLENITUDE) where volunteering refugees, migrant nurses, or doctors are connected with patients from poor socio-economic backgrounds	
Health, Environment	3, 15	Reusable facemasks	Reusable, affordable and biodegradable facemasks help preventing the spread of pandemic and protecting the environment (from the spread of disposable masks). A mask made from a proprietary cotton, embedded with accelerated copper oxide and silver particles, and a nanofiber textile that blocks pathogens would be a solution	Ecomask (Uganda)	ecoplastile.com/ecomask
Water	6	Fog harvesting	Large vertical mesh nets (called fog fence / fog collector / fog harp etc.) are installed in appropriate regions. Water drops condensed on the mesh flow down to a collector. Advanced instalments can collect up to 10% moisture in the air. Most advanced technology in this field is called the CloudFisher. Works better where humidity is high.	Water Foundation (uses CloudFisher)	Water Foundation (link for sample project in Bolivia)
Water	6	Water capture through the air	Moist air goes into a condenser box through filters. Air runs through springs cooled by refrigerant gases. Condensed water is ozonized for further filtration. Warm air blew out by fans that generate reverse ventilation for the inflow of moist air. Needs energy to operate, which can be supplied by solar panels.	AirDrink (France)	airdrink.fr/en/content/6-Drinkableair-awg-process

Sector	SDG	Technology	Description	Potential suppliers	Links (if available)
Water	6	Water capture via MOFs	MOF (Metal-Organic Framework) tech is used to capture water through dry air by the help of sunlight. With 1kg of powder-like MOF, 2.8 litres of water can be pulled in 12 hours under ambient sunlight (even when humidity is as low as 20-30%).	University of California, Berkeley (USA) Water Harvesting Inc. (USA, founded by the inventor of the tech. at UC Berkeley, Professor Omar Yaghi)	https://news.berkeley.edu/2017/04/13/device-pulls-water-from-dry-air-powered-only-by-the-sun/ https://pubs.acs.org/doi/10.1021/acscentsci.0c00678 http://www.wahainc.com/
Water	6	Water treatment with sunlight	Two 5lt of containers are joined like a book. Each container is filled with water and put under sun facing the transparent side up. Indicators located on each container turns green when UV purification is complete. Provides clean and hot water within 2-6 hours depending on the pathogens in water. Each unit has 7-10 years of life time. Used in Malawi.	Solvatten (Swedish Social Enterprise)	https://solvatten.org/
Water/ Agriculture	2, 6	Rainwater harvesting	Harvesting rainwater by collecting it in catchment areas installed on rooftops, ground or via big reservoirs. Filtration can be done at several levels. Filtered water can be used in-house (in WC reservoirs, for washing clothes), for irrigation and livestock feeding, even for drinking (advanced filtration is needed). Collector tanks can be above or under the ground. Commercial applications for large plants are also available.	Several (mostly NGOs)	https://www.stormsaver.com/commercial-rainwater-harvesting/how-it-works https://www.rainwaterharvesting.co.uk/ https://www.ctc-n.org/technologies/rainwater-harvesting https://www.savetherain.org/ VentureRadar
Water, Environment	6, 13	Flood Forecasting	With the help of ICT (computer vision, data analysis, image processing, AI etc.), and sensors/gauges/loggers implanted in rivers, groundwater hot-points early-warning systems can be established, and forecasting of floods can be made.	Many companies are working in this field. Selected ones are: Adasa (Spain) Cloud to Street (USA) ISMOP (Project, co-funded by National Centre of Research and Development of Poland) Fathom (UK, founded by the University of Bristol Hydrology Research Group	(Selected) https://www.adasasystems.com/en/ https://www.cloudtostreet.ai/ https://ismop.ki.agh.edu.pl/en https://www.fathom.global/fathom-global

Sector	SDG	Technology	Description	Potential suppliers	Links (if available)
Water, Environment	6, 13	Flood Protection	Innovative flood barriers provide protection from extreme waves of water and help redirecting the flow.	Innovative Global (Canada)	https://innovativeglobal.net/products/what-is-rapid-h2o/
Water, Environment	6,13	Permeable/ pervious paving	Permeable/pervious paving can: eliminate, or greatly reduce, stormwater run-off, protect urban fields from flood, and help recharging dwindling ground water.	Pervious Products (USA)	https://perviousproducts.com/

CHAPTER 7
TNA implementation plan and prioritisation

7 TNA implementation plan and prioritisation

Based on the needs and technologies identified for Lesotho in line with the issues and challenges facing the country discussed in the previous sections, the TNA implementation plan is given below for the technologies that needs to be prioritised for the country (Table 9).

Table 9. TNA implementation plan and prioritisation

Sector	Issues	Technologies	Responsible Organisations	Timing
Cross-sectoral	Limited access to Internet and internet infrastructure	• Establishing reliable Internet infrastructure throughout the country, making the internet cost affordable for the entire population and making low-cost ICT equipment available for citizens	Ministry of Communication, Science and Technology in cooperation with the Lesotho Communications Authority and private sector enterprises, including telecommunication companies, service providers, hardware vendors and training centres	Short-term
Agriculture & Food	Inadequate alternative water resources for household and farming use	• Establishing harvesting systems for collecting rainwater in catchment areas installed on rooftops, ground or via big reservoirs (to be implemented in different scales, from household usage and small farms to commercial applications for large plants).	Ministry of Water Affairs; Ministry of Agriculture and Food Security; Ministry of Communication, Science and Technology	Short-term
Agriculture & Food	Environmental degradation eroding fertile soils and land tenure	• Using flood monitoring and warning systems for timely detection of possible flood risks and floods	Ministry of Communication, Science and Technology; Ministry of Agriculture and Food Security; Ministry of Tourism, Environment and Culture; Ministry of Energy and Meteorology	Short-term
Agriculture & Food	Environmental degradation eroding fertile soils and Land Tenure	• Raising awareness of the impact of chemical pesticides, monoculture farming, inadequate usage of fertilizers etc. on productivity • Capacity building on the usage of organic farming alternatives and application of agricultural biotechnology • Adopting new technologies to increase productivity, such as precision/smart farming	Ministry of Agriculture and Food Security; Ministry of Water Affairs; Ministry of Forestry, Range and Soil Conservation; The academic institutions (e.g. Lesotho College of Education)	Short-term
Human health	Inadequate provision of quality health services	• Establishing telemedicine systems and services with video-consulting/ virtual-visit technologies to help patients reach physicians for remotely diagnosable conditions and for consultations	Ministry of Health; Ministry of Communication, Science and Technology; National Health Training College	Short-term
Education	STEM education not perceived as attractive especially among girls	• Obtaining/developing learning methods, curricula and infrastructure to improve students' - math and science skills for further STEM education , to motivate them for STEM oriented fields and create a skilled workforce needed for Industry 4.0	Ministry of Education and Training; Ministry of Communication, Science and Technology	Short-term

Sector	Issues	Technologies	Responsible Organisations	Timing
Education	Quality and effectiveness of TVET needs improvement	• Building workshops and labs for common use and implementing apprenticeship programmes with the private sector, especially in manufacturing, tourism, energy, agriculture and food sectors.	Ministry of Education and Training; Ministry of Communication, Science and Technology; Ministry of Trade and Industry; Private sector	Short-term
Education	Limited infrastructure and capacity to support online teaching and learning	• Developing online learning resources and curricula at all levels of education by ensuring the quality assurance in content and methods • Building capabilities and digital skills of teachers, lecturers, instructors and other facilitators of learning to better adopt on-line/remote education	Ministry of Education and Training; Ministry of Communication, Science and Technology; The academic institutions (e.g. Lesotho College of Education)	Short-term
Energy	Limited availability of reliable and stabile energy distribution and energy efficiency	• Establishing smart grid systems and microgrid technologies; automated energy management systems and home automation technologies • Achieving the digitalisation of the energy systems	Ministry of Energy and Meteorology; LEWA	Short-term
Human health	Inadequate production capabilities of medical supplies	• Creating capacities and establishing the infrastructure for the local production of basic medical supply such as reusable/biodegradable face masks, hydroalcoholic gel, medicine and basic items such as vaccines and painkillers	Ministry of Health; Relevant private sector initiatives.	Short-term
Agriculture & Food	Low agricultural production and productivity	• Monitoring crops, farms and fields with drones, UAVs (Unmanned Aerial Vehicles) and satellites • Applying techniques and technologies such as artificial intelligence, machine learning, Internet of Things from machinery automation to crop yield prediction & optimisation	Ministry of Agriculture and Food Security; Ministry of Communication, Science and Technology; Ministry of Education and Training; Ministry of Tourism, Environment and Culture; Ministry of Energy and Meteorology	Medium-term
Agriculture & Food	Environmental degradation eroding fertile soils and Land Tenure	• Obtaining and applying smart irrigation technologies for efficient use of resources and minimise wastage of water	Ministry of Agriculture and Food Security; Ministry of Water Affairs; Ministry of Forestry, Range and Soil Conservation	Medium-term
Agriculture & Food	Limited access to lucrative markets – both at local and international levels to promote commercial production	• Creating an effective value chain in agriculture with e-marketing solutions and a B2B platform connecting farmers with retail market actors	Ministry of Agriculture and Food Security; Ministry of Communication, Science and Technology; Ministry of Trade and Industry; Chamber of Commerce & Industry, and other relevant authorities	Medium-term
Agriculture & Food	Inconsistent quality of agricultural products	• Identifying and establishing quality and production standards in agriculture and food sectors • Establishing tracking and monitoring infrastructure from cultivation to market delivery with surveillance systems such as QR codes, mobile test kits, smart sensors	Ministry of Agriculture and Food Security	Medium-term

Sector	Issues	Technologies	Responsible Organisations	Timing
Human health	Limited capabilities for diagnosis and treatment of diseases	• Obtaining and using technologies and equipment for the diagnosis and treatment of human diseases and clinical research • Creating the infrastructure and capabilities for developing, producing and marketing traditional medicine	Ministry of Health; Ministry of Communication, Science and Technology	Medium-term
Arts, Culture and Heritage	Heritage sites under threat and need to be protected	• Using drones with cameras and GPS for documentation and monitoring of the heritage sites	Ministry of Tourism, Environment and Culture	Medium-term
Human health	Ineffective use of medicine	• Obtaining a Medicine Track & Trace System, using data matrix, Internet of Things and other related technologies to keep track of medicine (from import to its usage by patients) and avoiding its misuse, prevent counterfeiting, as well as managing supply chain and recalling the dangerous medicine	Ministry of Health; Ministry of Communications Science and Technology	Long-term
Youth development	Limited access to internet by young people limiting access to information, training, and enterprise development	• Making internet affordable for youth population for training and job search especially in rural and urban areas • Installing internet in the eleven District Youth Resource Centres in the and three Youth Vocational Training Centres in Lesotho	Ministry of Communication, Science and Technology, Econet, NGOs, Development Partners and other relevant organisations	Long-term
Youth development	Limited research to support evidence-based policy making and programme implementation	• Carrying out research, needs assessment, monitoring and evaluation systems for informing youth programmes and youth data-base (youth in school, out of school youth, employed, self-employed and unemployed youth, youth in business and young farmers and youth in different sectors)	Ministry of Communication, Science and Technology, Education, Agriculture and Food, Trade, Development Planning, Social Development, Public Service, Bureau of Statistics	Long-term

CHAPTER 8
Conclusions and recommendations

8 Conclusions and recommendations

As discussed in previous sections, Lesotho is making notable progress in developing and implementing STI policies and enhancing its national STI system. The high commitment of the government on STI and the strengths and potential of the country creates a strong foundation for its sustainable and inclusive development and graduation from the LDC category.

Within this framework, Lesotho will hugely benefit from the adoption and deployment of technologies addressing the needs of the priority sectors as well as the development of necessary skills and competencies for their use and development.

Therefore, it is recommended that the government

- Establishes a high-level oversight body for the coordination of STI policy implementation, and establishment of multi-stakeholder dialogue, design of a coherent STI policy mix, and integration of STI in other policy areas
- Creates the systems and builds capacities to regularly collect internationally comparable STI statistics as well as monitoring and evaluation mechanisms for policies and policy instruments
- Builds a balanced STI policy mix targeting not only start-ups and technology-based enterprises but also grass-roots innovators
- Develops human capital for STEM fields and attracts young people to pursue research career paths and innovation-based entrepreneurship, with a particular focus on attracting girls to STEM subjects to increase the participation of women in research and innovation
- Reviews and harmonises the regulatory framework and quality standards for TVET with the international best practices, increases investments in TVET with a particular focus on practical implementation and ensures private sector involvement in curriculum development and implementation including but not limited to apprenticeship programmes
- Enhances communication and collaboration between research performers and the private sector, also by integrating the FDI in the innovation ecosystem
- Invests in developing the quality, metrology and standardisation infrastructure, and offer internationally recognised certification in all sectors
- Establishes and strengthens research institutes to conduct and commercialise R&D in the priority areas
- Mainstream STI in the policies, programmes and projects implemented by the government and development partners.
- Establishing a university focusing on agricultural research and innovation, and offering graduate and postgraduate degrees

To support sustainable and inclusive development, it is recommended that the UN Technology Bank and other development actors assists Lesotho in

- The transfer and deployment of technologies identified and listed in this report giving the priority to those listed in the implementation plan provided above
- Developing necessary skills and capabilities in technology transfer and development
- Establishing an effective IP system, and drafting and enforcing the IPR -related legislation
- Raising awareness for the adoption and use of new technologies
- Creating a national technology transfer office to coordinate the technology adoption process as well as commercialisation of R&D outputs from universities, research institutes and start-ups
- Establishing an incubator/accelerator lab to foster R&D and innovation in biotechnology and biosafety for the agriculture and food sectors
- Developing TVET programmes and infrastructure to create a supply of intermediate-level employees (laboratory technicians, radiographers, renewable energy and energy efficiency experts, etc.) to be engaged in STI in the priority sectors.

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