Policy Study | Advisory Group on R&I for Africa-Europe Cooperation

Recommendations on how to make R&I a driver for sustainable development in AU-EU relations
Recommendations on how to make R&I a driver for sustainable development in AU-EU relations

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Directorate-General for Research and Innovation
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Recommendations on how to make R&I a driver for sustainable development in AU-EU relations

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FOREWORD

Strengthening the EU-Africa research and innovation partnership is critical for advancing green and digital transitions and forging stronger bonds among innovators, researchers, and educators.

Indeed, we are experiencing a new momentum in our EU-Africa relations. We have already formed solid cooperation in building further. Since 2016, we have set up EU-AU R&I Partnerships on Food and Sustainable Agriculture, Climate Change and Sustainable Energy with a joint investment of EUR 816 million. In the area of Health, the European and Developing Countries Clinical Trials Partnership involving 60 countries and a joint budget of almost 2 billion euros will continue to support collaborative research to develop accessible, suitable and affordable medical interventions. Moreover, more than 1700 African researchers from 44 countries and 181 African organisations have taken part in the Marie Sklodowska Curie Actions.

When I met with the European and African Ministers of Research and Innovation and the African Union Commissioner two years ago, we agreed to focus our cooperation in four areas: public health, capacities for science, innovation and technology, and green transition.

As a follow-up, we asked independent experts to advise how to best boost R&I cooperation in these areas. The group of multidisciplinary experts chosen was well balanced in nationality and gender. It included both established researchers and young researchers. This report presents the results of their work, including feedback obtained from over 500 African and European policymakers and other stakeholders.

It confirms the strong call for increased cooperation between the EU and the AU in four priority areas and more substantial synergies between R&I policies and instruments and those of International Partnerships. It also examines the technology challenges and strengths of the African R&I landscape. It proposes new areas for development in the EU-AU partnership.

The report also provides a solid evidence base for developing an EU-AU Innovation Agenda, which we committed to in 2020. The Africa Europe Innovation Partnership pilot we launched three years ago has already connected over 120 vibrant African and European start-ups and incubators. This report makes valuable recommendations on strengthening this partnership and making it more mutually beneficial while responding to local needs.

I am determined to continue identifying and implementing joint research and innovation EU-AU flagship initiatives. To be successful, we must continue to work with all relevant science, technology, and innovation actors and give them a strong voice in setting and implementing the agenda.

Enjoy the reading.

Commissioner Mariya Gabriel
European Commissioner for Innovation, Research, Culture, Education and Youth
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1. BACKGROUND TO THE POLICY STUDY

1.1. AFRICA-EU COOPERATION IN R&I

Africa and the EU have a long-term, broad and evolving cooperation that spans a range of social, cultural, economic and political areas. In recent years, the relationship between the African Union (AU) and the European Union (EU) has grown closer and become more diversified in the area of research and innovation (R&I). A range of strategies and policy initiatives provide the framework and impetus for continued cooperation in this field.

The second AU-EU Summit in 2007 launched the Joint Africa-EU strategy (JAES), which features multiannual action plans for specific priority areas. At the third AU-EU Summit in 2010, cooperation was further enhanced with the launch of the AU-EU High-level policy dialogue on science, technology and innovation (HLPD), a platform for formulating joint AU-EU cooperation activities in the field of R&I.

In March 2020, the EU published the communication 'Towards a comprehensive strategy with Africa' presenting EU proposals in view of defining a joint partnership agenda with the AU at the sixth AU-EU Summit (originally planned in 2020 but postponed to 2022). It proposed five EU-Africa partnerships: green transition and energy access; digital transformation; sustainable growth and jobs; peace and governance; and migration and mobility.

Following up on the proposed Africa strategy and the HLPD plenary on science, technology and innovation held in June 2020, the first AU-EU R&I Ministers’ meeting took place in July 2020. During the meeting, the following four thematic priorities to shape future cooperation between the two continents were agreed: public health; green transition; innovation and technology; and capacities for science. Various AU-EU networks and long-term R&I partnerships are active within these priority areas, striving for a joint and sustainable implementation of the priorities.

These priorities are also part of the recently launched EU R&I programme Horizon Europe (2021–2027). One of its components - the global approach to R&I - promotes a general openness to international participation and aims to deliver new solutions to green, digital, health and innovation challenges. African researchers are key partners in achieving these goals. This is also reflected in the Africa initiative, launched in June 2021 as part of Horizon Europe. This initiative aims to strengthen long-term cooperation in finding solutions to promote global public health, socio-economic development and the recovery from COVID-19, in line with the four priority areas.

The EU recently launched the Neighbourhood, Development and International Cooperation Instrument (NDICI) – Global Europe, which will streamline and simplify the EU's external financing instruments for international cooperation with partner countries. It will cover the European neighbourhood (including North Africa), Sub-Saharan Africa, Asia and the Pacific, and the Americas and the Caribbean. Among the many thematic areas, it will include Science, Technology and Innovation.

Moreover, the new EU-OACPS Partnership Agreement (Organisation of African, Caribbean and Pacific States), initialled on April 2021 and which is yet to be signed and concluded, substantially modernises and embraces R&I cooperation, extending the scope and scale of EU and OACPS ambitions to better address challenges and governance.

From the African Union’s side, two main policies frame the transcontinental R&I cooperation. Agenda 2063 is the AU’s strategy to deliver on its goal for inclusive and sustainable development. The science, technology and innovation strategy for Africa (STISA-2024) is the first of the 10-year incremental phasing strategies to meet the need for science, technology and innovation to have a positive impact on agriculture, clean energy, education, environment, health, infrastructure development, mining, security and water on the African continent.
1.2. **MANDATE OF THE R&I ADVISORY GROUP**

In line with the four priorities set by the AU and EU R&I Ministers in 2020, the European Commission’s Directorates-General for Research and Innovation and for International Partnerships commissioned an Advisory Group (AG) on R&I for Africa-Europe cooperation. The group serves to guide the Commission on how best to mainstream and boost R&I cooperation in the fields of health systems, R&I capacities, innovation and technology, and the green transition. The goal is to make R&I part of a positive cooperation agenda between Africa and Europe to support a global knowledge exchange as a crucial path to enhanced sustainable development.

The AG was specifically requested to provide input on regional and national EU programmes, with a special focus on actions beyond 2024. The AG will assist AU and EU policymakers in defining future priorities, covering both policy direction and implementation, in line with or, as necessary, independent from current programmes.

The AG is composed of six high-level experts and six research assistants, with equal representation from Africa and Europe. The experts cover a wide range of cross-cutting themes covering capacity building, innovation uptake, data monitoring and policy advice within the four thematic pillars.

This policy paper presents the results of the AG’s work, including feedback obtained from over 500 African and European policymakers and other stakeholders. The paper provides expert opinions and an evidence base for the future needs of science, technology and innovation development. It includes recommendations for funding instruments and priority actions for the dialogue between AU and EU policymakers.
2. HEALTH AND HEALTH SYSTEMS

By Prof Marleen Temmerman, Dr Sonia Abdelhak, Dr Yosr Hamdi and Nellah Ndaka

2.1. EXECUTIVE SUMMARY

Strengthening health systems is based on the core principles of primary health care outlined at Alma-Ata in 1978, reinterpreted to account for major changes in recent decades in the demographic, climatic, technological and geopolitical spheres. Recently, there has been growing attention not only to improve population health but also to build resilient health systems, considering changing epidemiology and health emergency preparedness & response, key to controlling emerging public health challenges at both national and international levels.

The following priority areas are identified in AU-EU R&I cooperation for health systems:

- Capacity building in R&I for health and health systems;
- Ethics and regulatory framework;
- Knowledge translation into policies, practices, health products and services to benefit African populations; the ‘know-do’ gap.

The study finds that R&I is a key driver for social and economic development with enormous transformational potential in the health area. However, in order to strengthen and leverage the sustainability, efficiency and impact of R&I in African-European health cooperation major shifts in paradigm are needed. Thematical, health should focus on strong resilient public health systems, enforced by vertical programmes aligned to the local needs of countries, built on strategic planning and health systems governance, health financing and effective development cooperation, as key to achieve UHC. Furthermore, the unfinished MDG agenda, the SDGs framework and the overall health emergency preparedness and response should steer the thematic priorities. Great emphasis should be paid to equity in R&I, involving African researchers and stakeholders in the design and development phase of research programmes. Measures aimed at equity and diversity that encourage and support women and other minority groups in science are needed. A good model for collaboration is the EDCTP, an equal partnership and true co-ownership of strategy and activities between Africa and Europe. EDCTP has established a well-defined niche in global health, with networks of excellence in Africa and Europe. Evidence-based research needs to inform policy (implementation research), research should be integrated to create local markets (innovation and research nexus) and research should further be embedded into national health systems. Digital technology needs to be leveraged to foster international collaboration to allow cross-boundary scientific research. Future health systems need to be built on digital platforms. Harnessing data science by establishing strong data-science platforms, artificial intelligence as well as in Big Data governance in the health sector, needs further investment, in particular in the area of precision medicine and public health. Open science, increasing accessibility to the output of publicly funded research in digital format to the scientific community, the business sector, or society more generally needs to be supported, to promote long-term research as well as innovation.

Based on these findings, the following policy recommendations can be made for how to mainstream health into African-European R&I collaboration.

- Capacity building in R&I health and health systems: not only do research institutions require strengthening and upscaling, but also the users of knowledge and evidence such as health policy makers, government officials and decision makers who manage, analyse and use data to better respond to health issues and inform policy & decision making.
• **Ethics and regulation framework**: there is a need to create adequate and harmonised regulatory and ethical systems in all fields related to health, in particular health research and clinical trials in Africa, to further promote practices that respect international guidelines and protect human rights and dignity.

• **Applying solutions in practice in health policies** (the ‘know-do gap’) : While academics have produced solutions to many health challenges, these need to be translated into policies, laws, guidelines and practices.

• Expand and **empower health R&I networks**, based on equity, and agendas driven by local, national and regional needs. Co-creation is important, not only at the implementation level but at the design development phase. Allow African institutions to lead large programmes, based on merit and capacity.

• Encourage the creation of more **EDCTP-modelled collaborations** in other priority areas of health cooperation that complement and maximise the impacts of the EDCTP, thus creating a more sustainable and enabling environment for health R&I in Africa.

• **Strengthen and promote collaboration of national ethics committees and national regulatory authorities** to facilitate long-term development plans towards regional harmonisation goals.

• **Support the participation of civil society and patients** in the design, implementation, monitoring and evaluation of health R&I policies, for example in the AU-EU High-Level Policy Dialogue (HLPD) on Science, Technology and Innovation and other relevant platforms.

• **Invest in knowledge synthesis and translation and in science and health diplomacy**.

• **Blended financing mechanisms** with domestic funding (1% of GDP) and external funding, applying simplified external funding instruments, are required.

• **High-level coordination** between DG RTD and DG INTPA, the AU, delegations in member states and other global partners, has the potential to improve the impact of joint strategies and programmes.

### 2.2. STATE OF PLAY & PRIORITY TOPICS IN HEALTH AND HEALTH SYSTEMS

The strengthening of health systems is based on the core principles of primary health care outlined at Alma-Ata in 1978. While these principles are still valid, they have been reinterpreted in light of significant changes in the health field that occurred in the last decades, such as demographic shifts, climatic changes, technological revolution, and geopolitical changes (Kieny et al. 2017). The 2030 agenda for sustainable development puts health as a central component of development.

Under the 17 Sustainable Development Goals (SDGs), goal 3 ‘to ensure healthy lives and promote well-being for all at all ages’ and target 3.8 on universal health coverage (UHC) emphasise the importance of access to quality health services without risking financial hardship. Health system strengthening is also considered a means to progress towards UHC. According to the Lancet Global Health Commission on High-

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1. The WHO defines health systems as the whole environment that comprises all organisations, institutions and resources whose primary purpose is to improve health.

2. These principles include: universal access and coverage on the basis of need; health equity as part of development oriented to social justice; community participation in defining and implementing health agendas; and intersectoral approaches to health.

3. Health system strengthening refers to significant and purposeful efforts to improve the system’s performance. Strengthening is one way to ensure that the system’s performance embodies the intermediary objectives of most national health policies, plans and strategies – quality, equity, efficiency, accountability, resilience and sustainability.
Quality Health Systems in the SDG era, ‘health system quality in lower-income countries has been under-defined and under-researched and an agreed upon single definition of a high-quality health system is missing’.

Indeed, robust data systems are required to measure and monitor the performance and quality of health systems and services (Kruk et al. 2017). This highlights the importance of health systems research⁴, also known as health policy and systems research, to draw a comprehensive picture of how health systems respond and adapt to health policies, and how health policies can shape – and be shaped by – health systems and the broader determinants of health (Gilson 2012). Clift and Gotham mapped the global research-for-health ecosystem and the linkages between health, health research and research systems and the broader macro-environment in a scoping review (Clift and Gotham 2019), illustrated by figure 1 below.

![Figure 1: Linkages between the health, health research and research systems and the broader macro-environment (ibid.)](image)

At the global level, 2015 was the end point of the United Nations (UN) Millennium Development Goals (MDGs), and marked the transition to the Sustainable Development Goals (SDGs). It was also the 20th anniversary of both the International Conference on Population and Development (ICPD) and the Beijing Declaration and Platform for Action. Although great strides have been made to meet the MDGs, showing that change is possible, many countries are lagging behind in reaching MDG goal 4 and goal 5 with vast inequities between and within countries (Temmerman et al. 2015). In 2010, confronted with unacceptably high rates of maternal and child mortality, the UN Secretary-General called on the world to develop a strategy to improve maternal and child health in the world’s poorest and high-burden countries, starting with 49 low-income countries.

The 2010 Global Strategy for Women’s and Children’s Health was a bellwether for the "Every Woman Every Child⁵" global movement that led to significant progress worldwide in women’s and children’s survival and health. However, despite decades of unprecedented medical advances and innovations in healthcare, the quality of care in general — and of women’s, children’s, and adolescents’ health in particular — is often weak. Based on the life-course approach of interventions and the goal of UHC, papers (ibid.) highlight the

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⁴ Health policy and systems research is a multidisciplinary scientific field that provides evidence that can make healthcare affordable, safe, effective, equitable, accessible, and patient-centred. It seeks to understand and improve how societies organise themselves in achieving collective health goals, and how different actors interact in the policy and implementation processes to contribute to policy outcomes. By nature, it is interdisciplinary, a blend of economics, sociology, anthropology, political science, public health and epidemiology.

⁵ Movement that mobilised stakeholders in all sectors to work towards shared goals. It encouraged national leadership, attracted new resources and financial commitments, supported research and innovation, and created a worldwide movement of champions for the health and well-being of every woman and every child.
critical interventions and actions needed to ensure that women, children and adolescents around the world are able to survive, thrive and transform.

The 2013 Lancet Commission on Investing in Health report (Jamison et al. 2013) concluded that a grand convergence in health — a reduction in infection, child and maternal mortality rates seen in the best-performing middle-income countries — is technically and financially feasible for all but the poorest countries by 2035 (Watkins et al. 2018).

The aforementioned reports demonstrate the change in the global health situation and environment. There has been growing attention accorded not only to improving population health but also to building resilient health systems, considering changing epidemiology and pandemic preparedness. The 2030 Agenda for Sustainable Development provides new goals and action targets for human well-being and development (Cheng et al. 2021).

The COVID-19 pandemic, however, has revealed areas for improvement in health emergency preparedness beyond the current pandemic, whose impact will be long-lasting. Its impact will influence all spheres of human lives and slow all developmental activities, including the SDGs that were adopted to reduce poverty, to improve the quality of life of all citizens as well as to carry forward the unfinished agenda of the MDGs (Khetrapal and Bhatia 2020). Indeed, it will be essential to make policy adjustments and transformations as all countries work towards UHC.

At the European regional level, there is a new political environment in the EU and its member states in the context of changing geopolitical realities, and the altered global health landscape, more specifically in terms of financing (The Global Health Centre 2020). For some time now, the European Commission (EC) has emphasised a geopolitical perspective of EU external affairs, one that gradually evolved from neighbourhood policy to partnerships. This perspective is being extended to include other regions of the world, such as the African continent, and is set to shape African Union-European Union (AU-EU) relations in health systems (Council of the EU 2020). In May 2021, the European Commission published a Communication on the Global Approach to R&I - Europe's strategy for international cooperation in a changing world that is quoted below (European Commission 2021d):

"In line with the Joint Communication 'Towards a comprehensive strategy with Africa', the EU seeks to enhance its cooperation with Africa in research and innovation. Making effective use of science, technology and innovation accelerates sustainable and inclusive development and the transition to knowledge-based societies and economies strengthening human capital notably through mobility and training of academics and researchers. To meet these challenges, whose urgency has increased due to the COVID-19 pandemic, the EU proposes a series of ambitious regional initiatives.

The Commission, working closely with the African Union Commission, proposes to implement a series of initiatives under Horizon Europe constituting a comprehensive and ambitious ‘Africa Initiative’. This will support the agreement reached at the July 2020 Ministerial meeting of the [...] HLPD. Four pillars of cooperation should be supported: (i) public health, including resilience and pandemic preparedness (ii) the green transition; (iii) innovation and technology for job creation; and (iv) capacities for science and higher education, particularly for women and youth.

In addition, a European Union-African Union Innovation Agenda should support the transformation of research and innovation outputs into products and services with a concrete impact, through various measures that improve business development and access to finance for innovators. The priority given to cooperation with Africa includes the long-standing bilateral cooperation with South Africa, and comes in parallel with the EU’s continuing its partnerships with other parts of the world combining resources of the EU, Member States, and financial institutions through Team Europe initiatives. The Team Europe initiative will greatly strengthen pharmaceutical and health systems, thus creating an enabling environment for sustainability. It will contribute to developing human resources by investing in skills and education, by
increasing African research capacities, and by enhancing scientific cooperation between the two continents.”

On the African continent, new prospects and challenges are emerging from economic, political, social, technological, demographic, climate and environmental changes. In August 2020, the World Health Organisation (WHO) Regional Committee for Africa, involving ministers of health from member states of the African Region, stressed the importance of investing in health systems and of focusing on emergency preparedness on the continent. Dr Matshidiso Moeti, WHO regional director for Africa, noted that, ‘The coronavirus pandemic has proven once again the importance of investing in health systems, enhancing equitable access to care and improving readiness to prevent and control outbreaks. Recovering from this pandemic will be incomplete without strong measures to bolster health systems. We must seize the opportunity and make the leap for a better tomorrow.’ The WHO recommended member states to find ways to increase public funding to develop health systems, explore initiatives to boost access to services, review and identify the needed health system investments, set up measures to monitor the performance of health systems at the subnational level and enhance the efficiency of available funding, particularly donor, private and out-of-pocket funds.

Indeed, the changing context, transitioning from the MDGs to the SDGs, together with changing population dynamics, environment and climate change, is leading to a more inclusive global health agenda. More attention is being given to the unfinished MDG agenda (maternal and perinatal health issues, as well as HIV, Malaria and Tuberculosis which are still major killers on the African continent), but also to non-communicable diseases (NCDs), mental health and adolescents’ health.

In addition, COVID-19 has exposed many gaps and challenges in global epidemic preparedness. Tackling the current pandemic, increasing international cooperation in global health, and improving epidemic preparedness and health security are current priorities of the EU, including providing support to low and middle-income countries (LMICs). Moreover, the pandemic has also shown the importance of new technologies such as next-generation sequencing technologies and of genomic-informed pathogen surveillance (Inzaule et al. 2021) for disease surveillance and outbreak management in Africa.

Although precision medicine⁶ is announced among the priorities for health included in the Science, Technology and Innovation Strategy for Africa (STISA-2024), it is still often considered a luxury. Indeed, one of the challenges faced by the scientific community is getting their governments to accept the establishment of technology platforms and, considering their cost burden, to find ways to maintain these platforms and make them operational.

The COVID-19 crisis has, nonetheless, resulted in a boom for researchers in some countries (such as Nigeria, Senegal and Tunisia) who have succeeded in convincing decision-makers of the need to set up next-generation high-throughput sequencing platforms. The establishment of these platforms will be very useful not only for epidemiological surveillance as recommended by the WHO (World Health Organization 2021), but also to implement genomic medicine for public health in Africa. Finally, a framework has been established within the science prioritisation exercises conducted under the Africa’s Scientific Priorities Programme (ASP), a five-year initiative being implemented by the AAS-AESA in partnership with AUDANEPAD (African Academy of Sciences 2021a) to allow setting up precision public health in Africa (Khoury et al. 2020).

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⁶ The term ‘precision medicine’ describes the use of specific information about an individual to facilitate a more precise approach to their healthcare.
2.3. RESEARCH QUESTIONS AND METHODOLOGY

Based on the evidence set out in the previous section, the following research questions and priority areas have been identified:

- What are the imperative needs of capacity building in R&I for health and health systems?
- Which improvements are needed for ethics and regulatory frameworks?
- How to bridge the `know-do gap´, or rather: how to ensure the translation of knowledge into policies, practices, health products and services to benefit African populations?
- What are the priority topics and thematic areas to be addressed in the next AU-EU health agenda?
- What are the main cross-cutting themes to be tackled jointly with the other three AG topics (R&I capacities, innovation and technology and green transition)?

Methodologically, the AG conducted a situation analysis to critically evaluate the internal and external conditions that are affecting health and health systems research in Africa:

- A literature review was performed to analyse, synthesise and critically review the current situation of health systems and health systems research in Africa, and the impact of AU-EU cooperation on this field during the last decade. The AG compiled a list of publications, reports, briefs and declarations, mainly those produced by official organisations and research networks, considered to be influential or important. Civil society organisations and the private sector institutions were included.

- Key informants’ interviews with leading organisations in the AU-EU space were identified and consulted, including EDCTP, WHO-Afro, ACDC, ECDC, EMA, AMA, AAS, AUDA-NEPAD and others. Stakeholders at global, regional and national levels in Africa and Europe were invited and through a snowball approach, the list of organisations and individual experts was expanded to ensure representation from low- and middle-income countries (LMICs). This resulted in a list of nearly 50 stakeholders, who the AG invited for interviews, using a semi-structured interview guide (see annex). All sessions were recorded, transcribed and analysed. Qualitative data analysis was done to identify the main themes emerging from the interviews.

- Global consultation of the draft policy reports of the AG was conducted in July 2021, followed by a validation workshop. The input gathered from these consultations further informs the findings of this policy brief.

2.4. ANALYSIS AND FINDINGS

Based on the literature review, interview analysis and the stakeholders’ input, the AG identified the following priority areas in health systems R&I and in emergency preparedness:

- Capacity building in R&I in health and health systems
- Ethics and regulatory ecosystem.
- Bridging the evidence synthesis/knowledge gaps and health policies, practices, interventions and implementation; the know-do gap.
- Thematic health priorities.
This section will be presented under these main pillars identified as key priority areas for R&I and development cooperation in the health sector between the AU and EU.

**2.4.1. R&I capacity building in health and health systems**

The goal of health innovation and research (Amref Health Africa) is to improve the ability to meet public and personal health needs and demands by optimising the performance of the health system for increased access to sustainable prevention of health problems and quality healthcare. According to the WHO, health innovation is an important element in the efforts to achieve UHC and the SDGs. It is in this light that the WHO recommends greater investment in digital health, digital health literacy and ICT infrastructure, with future health systems built on digital platforms and putting the right policies in place to boost creativity and entrepreneurship and to bolster university-led research (World Health Organization 2020b).

Unfortunately, there is still an obvious digital divide that exists in Africa making the access to digital health solutions impossible for many; an estimated number of 900 million people in Africa lack the means of internet connectivity (European Investment Bank 2020). African countries need support for data and digital transformation. Data management is key in R&D; a wealth of data is available in countries but often of poor quality and fragmented.

There is insufficient clinical research capacity for tackling infectious diseases in sub-Saharan Africa, and limited knowledge exchange and research collaboration. A collaborative approach is required to develop and evaluate vaccines, drugs and other tools needed to control these diseases. Collaboration between public and private funders, together with research institutes, product development partnerships and national health authorities, is therefore key to further progress. The COVID-19 pandemic has clearly illustrated the importance of local research capacity as a key element of pandemic preparedness.

Research capacity not only includes the strength of universities, research institutes and networks, but also the capacity of users, including government officials and decision makers, to use research data to feed their strategic decisions and programmes. The SCORE for Health Data Technical Package, developed by the WHO and partners (World Health Organization 2020c) is a new and powerful tool to help member states strengthen country data systems and their capacity to monitor progress towards the health-related SDGs, the WHO Triple Billion targets (World Health Organization 2020e), and other national and subnational health priorities. It also addresses weak civil registration and vital statistics in many African countries, and will promote health systems accountability (World Health Organization 2020d).

In addition, innovations in telemedicine, artificial intelligence, genomics and genetics, precision medicine, new essential drugs, digitally supported delivery systems, and solar power are key components of R&I for health services and systems.

For effective population health interventions, research is also needed on behavioural insights addressing acceptability, misconceptions, beliefs, and stigmas that determine the uptake of interventions and programmes.

The following section results from the analysis of interviews with respondents on the role of R&I in health systems.

**Imperative need for capacity building**

The achievement of UHC and the global health security agenda depends significantly on the capacity of health systems. This is also reflected by SDG target 17.9 on capacity building. Through North-South, South-South and triangular cooperation, it will be possible to further **enhance international support for implementing effective and targeted capacity-building in developing countries** while supporting national plans to implement all 17 SDGs (Sustainable Development Knowledge Platform).
There is need for clear guidance on health systems strengthening and establishment of uniform metrics for evaluating health systems that includes a framework highlighting common vulnerabilities in lower performing African health systems. To address this gap, WHO-AFRO launched the national health research systems (NHRS) strengthening barometer (Kirigia et al. 2015) facilitating evaluation of various components of NHRS based on 18 indicators and metrics. A key finding from the barometer is that there is a need for national governments to effectively execute their leadership and governance of NHRS and to create an enabling environment within which research for health can flourish. These indicators, however, may not fully capture the nuances in different health systems. Supplementary figure 1 in the annex maps the heterogeneous landscape of both weak and strong public health systems in Africa based on world development indicators.

Diversifying the public health workforce in Africa necessitates upscaling capacity through training opportunities for young and mid-level researchers at both individual and institutional level. Universities, research institutes, networks of excellence in research need to grow and develop their institutional research capacity, not only to become quality research hubs in Africa, but also to scale up to be the future lead research institutions on the continent.

Not only do research institutions require strengthening and upscaling, but also the users of knowledge and evidence such as health policy makers, government technical officers and decision makers who have to be able to manage, analyse and use data to better respond to health issues. Lack of capacity and understanding of epidemiology at the level of the decision makers (Ministries of health and others) hinders efficient collection of epidemiological data and monitoring, analysis and interpretation of data to inform policy and decision making. The joint EDCTP-ACDC programme (EDCTP 2021) has responded to these needs and invested in capacity building and training for health officials in epidemiology and statistics, to support the pandemic response in Africa.

Health challenges and health system set-ups warrant contextualised healthcare interventions to move towards UHC, with an emphasis on the generation of evidence to solve local challenges (Rusakaniko et al. 2019).

Pandemic preparedness on the African continent will require building the capacity for pharmaceuticals, diagnostics, vaccine manufacturing and accompanying measures such as cold chains and distribution routes. The low manufacturing capacity for vaccines and therapeutics is a key obstacle to the autonomy of African countries. The ACDC and the AU have responded to this need by launching The Partnerships for African Vaccine Manufacturing, set to develop regional manufacturing hubs in South Africa, Senegal, Egypt, Morocco and Rwanda (African Union and Africa CDC 2021).

Patenting is identified as a gap in the innovation research system in Africa, in particular, ownership of patents by African counterparts is identified as a challenge for AU-EU cooperation. Africa should have its own patent office.

Research ecosystem and practices

Currently, many EU programmes lack involvement of African member states or stakeholders in the design and development phase. African countries are mainly involved in the implementation plans, which is in contradiction with the EU principles of effective development cooperation.

The EU invests millions in health projects in Africa annually, yet the programming of these funds rarely considers EU investment in health in that country via other programmes (e.g. R&I cooperation). This is often related to the fact that EU delegations in Africa do not have research (and often even health) experts in their teams. EU delegations typically liaise with decision-makers, officials and stakeholders to identify the priorities for development cooperation and develop the annual action plans, including the calls for proposals. However, these delegations need staff trained in the field of health systems with a
comprehensive understanding of the needs and challenges on the African continent, as well as the relevant actors or initiatives in the region to gather that information; e.g. EDCTP projects implemented in their countries, or EDCTP Networks of Excellence. Developing capacities on health and research in EU delegations is critical to improve the consistency, alignment and effectiveness of EU initiatives in Africa. It is also a prerequisite for ensuring Africa-EU R&I cooperation is driven by local needs and expertise. The alignment and integration between DG RTD and INTPA is a great step in this direction. Indeed, R&I should be mainstreamed in development as well as development being the goal of investing in research.

Significant structural challenges contribute to low research output on the African continent. These include a scarcity of well-trained and skilled researchers and research institutes resulting in poor supervision of higher degree scholars, lack of a critical mass of researchers even where pockets of excellence exist, weak or very limited progression pathways for those in scientific careers, and poor research infrastructure, including a lack of access to scholarly tools such as scientific literature (Kasprowicz et al. 2020). Brain drain has to be addressed by providing more institutional capacity to allow growth and development for young researchers and their home institutions. A good example is the EDCTP programme, which has a retention rate of African talent of over 90%.

In recent years, tools have been developed to measure and improve research partnerships and codes of conduct, such as the Research Fairness Index (RFI) to measure research fairness in African countries and improve quality health systems partnerships and R&I equity. The index was designed by the Council on Health Research for Development (COHRED) with several leading research institutions around the world, as a tool for promoting self-reflection on, and public reporting of, institutional practices and policies related to research partnerships. The aim is to create a continuous improvement process for research collaborations (Lavery and IJsselmuiden 2018). The index allows researchers to share the first systematic global evidence base for practices, policies, strategies, standards and benchmarks and how they contribute to fair partnerships. In the various EU R&I framework programmes, there are specific recommendations and a global code of conduct for research in resource-poor settings (Global Code of Conduct). These tools should be applied systematically.

The importance of moving towards African-led research, co-designing and co-funding of programmes with African counterparts was underlined. Complex procedures for setting up and implementing EU-funded projects, including financial aspects, discourage African applicants from taking the lead to coordinate projects. EU-funded projects contract European institutions to manage the grants, enabling Africans to be principal investigators, but African institutions are rarely in the lead. Inequalities are mentioned in decision-making powers, co-creation, overheads and salary structures, as well as pathways with clear start points, and step-down priorities need to be mutually agreed. This gap could be addressed by increasing numbers of African principal investigators as well as African institutions leading the grant contracts in Horizon Europe programmes.

R&D capacity has increased in recent years on the African continent. However, few African countries are close to the 1% of GDP dedicated to Science, Technology and Innovation (STI) target agreed amongst AU member states in 2019 as part of the Science, Technology and Innovation Strategy for Africa (STISA-2024) (African Union Commission 2019). Kenya, South Africa (Centre for Science, Technology and Innovation Indicators 2021) and Egypt have emerged as major research hubs in the past decade; Kenya has invested about 0.8%, South Africa 0.75% and Egypt 0.6% of their GDP (UNESCO Institute for Statistics). Domestic funding still needs to increase, as well as programmes that blend domestic funds with funds from international organisations.

Evidence-based research to inform policy (implementation research), integration of research to create local markets (innovation and research nexus) and embedding of research in the national health systems needs more attention.
Measures aimed at equity and diversity that encourage women and support women and other minority groups in science are needed.

**Digital technology**

Digital technology should be used to foster international collaboration, enabling cross-boundary scientific research at regional and sub-regional level. The establishment of Sars-CoV-2 data hubs in African countries under the COVID-19 Data Platform initiative for example, will **facilitate participation in open data sharing and analysis** to accelerate COVID-19 research, and build capacity in digital data storing and sharing technology (Covid-19 data portal). In addition, the **use of artificial intelligence in the implementation of precision medicine and public health** in Africa (Khoury et al. 2020) as well as in **big data governance** is needed (African Academy of Sciences 2021b). Harnessing data science and establishing strong data-science platforms in Africa should be part of precision medicine implementation on the continent (Pereira et al. 2021). An example of this is the “Harnessing Data Science for Health Discovery and Innovation in Africa”, a programme supported by the National Institutes of Health (NIH) that aims to develop solutions to the continent’s most pressing public health problems through a robust ecosystem of new partners from academic, government, and private sectors (Breugelmans et al. 2015; DSI-Africa 2021).

**Open science**

Open science commonly refers to efforts to make the output of publicly funded research more widely accessible in digital format to the scientific community, the business sector, or society more generally to promote long-term research as well as innovation. Supplementary figure 2 in the annex highlights the need for open science through all stages of the research cycle, a concept that African researchers involved in European Horizon 2020 projects have been familiarised with, especially in relation to dissemination activities (InSPIRES Project). In the context of the COVID-19 pandemic, UNESCO has also established a recommendation on operationalising open science, targeting various regions of the globe to allow **open science for community engagement, data sharing and technology transfer that supports the strengthening of health systems**. Bibliometric analysis has shown an international collaboration advantage (Breugelmans et al. 2018). Indeed, a study has shown that the volume and citation impact of papers from sub-Saharan Africa has increased since 2003, as has collaborative research between Europe and sub-Saharan Africa. In addition, >90% of publications from EDCTP-funded research were published in high-impact journals and are highly cited. These findings corroborate the benefit of collaborative research on poverty-related diseases (Breugelmans et al. 2015).

**Sustainable financing for health and health systems research**

More domestic funding for health systems research is needed. The government of South Africa has demonstrated its commitment to health R&D by adopting a number of policies and strategies aimed at bolstering the country’s R&I agenda (PATH).

The ability to inject emergency funds into health systems is essential for resilient health systems; the prerequisite for this, however, is having strong public health budgets. Countries must be willing to consider centralised funding of health systems through hypothecated taxes or compulsory, broad-based insurance schemes.

The possibility of leveraging mutual funds and health insurance to improve access to healthcare is brought up, citing the example of Rwanda where the country’s community-based health insurance scheme (Mutuelles de santé) covers 84% of the population (Makaka et al. 2012).

Mechanisms for assessing health financing efficiency have to be developed. Indeed, health financing solutions are not a ‘one size fits all’ model, but require tailored, country-specific approaches that address
the unique needs of countries (Ifeagwu et al. 2021). Research should focus on UHC within all African countries, especially to strengthen evidence-based policy development, addressing complex research gaps such as performance monitoring, impact evaluation, return on investment and dynamics of stakeholder collaboration.

2.4.2. Ethics and regulatory environment

While the regulation of health products and services is an essential aspect of a functioning health system, setting adequate and uniform regulatory and ethical frameworks in all fields related to health, in particular health research and clinical trials in Africa, will further promote appropriate practices that respect international guidelines and protect human rights and dignity.

To improve regulatory capacity and infrastructure in Africa, a number of countries are working to align with their neighbours — by pooling resources (both technical and financial), sharing information and increasing collaboration across borders. Regulatory alignment across Africa has been endorsed at the highest political levels, and efforts to align regulatory policies across regional economic communities are already having a positive impact – for example, drug approval times have already been reduced by half in the East African community (Sillo et al. 2020).

Among the current initiatives on ethics and regulatory aspects we cite:

- Networking between national regulatory agencies, through AVAREF (an informal capacity-building platform established by WHO in 2006, aiming to improve regulatory oversight of interventional clinical trials conducted in Africa) (World Health Organization 2020a) and the African Medicines Regulatory Harmonisation (AMRH). The two agencies are now collaborating to bring their skills together to shape and support the creation of an African Medicines Agency (AMA) (Ncube et al. 2021), akin to the European Medicines Agency.

- Establishment of platforms and training opportunities supporting African ethics committees and research community, such as:
  - The RHInO ethics platform to improve the performance of ethics committees and regulators in Africa (EDCTP).
  - The MARC project, headed by COHRED, to document the ethics capacity in Africa, promote stronger capacity and help develop African accreditation criteria. This initiative will directly address the challenges faced, including lack of tools for efficiently coordinating the submission and review of protocols and their timely communication to researchers in regional economic communities in Africa.
  - The AfriEthique project, funded by EDCTP to strengthen ethics committees and regulatory authorities from Central African countries: The Democratic Republic of Congo, the Republic of Central Africa, Chad, and the Republic of Congo (EDCTP 2019a).

Despite this progress, many barriers are still hindering the realisation of African leaders’ vision of a single, continent-wide AMA (Ncube et al. 2021):

- The diverse and heterogeneous ethics and regulatory landscape among African countries, which often have varied technical capacity7, makes it difficult to offer a single continental approach to governing regulatory frameworks.

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7 The National Health Research Ethics Council code of conduct, developed in South Africa, is a unified interpretation of the law, which aligns responses across South African universities. South Africa has also created a protection of personal information act (POPIA) that is equivalent to the GDPR (National Health Research Ethics Council (2003)).
A lack of sustained funding specific to ethics and research on ethics aspects on the African continent, compounded by an over-reliance on a small number of donors (Park 2019).

Limited ICT infrastructure that hinders exchange and communication between African partners.

The tendency to directly apply the European General Data Protection Regulation 2016/679 (GDPR) to the African continent, which limits cross-border transfer to countries without similar protections (which is the case in most African countries). An asymmetry is noted between many of the regional instruments that provide obligations to African countries to develop corresponding legislation, where the GDPR is regarded as more effective in shaping national legislation than instruments and conventions developed in Africa. The GDPR should serve only as a model for privacy legislation and a reference for legislative alignment (African Declaration on Internet Rights and Freedoms Coalition 2021).

2.4.3. Bridging the evidence synthesis/knowledge gaps and health policies, practices and implementation

While the research community has produced solutions to many challenges related to health, there is a need for such solutions and innovations to be translated into policies, laws, guidelines and practices. There is a gap between the research communities, whose agendas are often grant/donor-driven, and the health priorities on the ground. This translation deficit is global, but much worse in low- and middle-income countries (LMICs) and mainly in Africa, where the communication gap between academics and policymakers needs more attention.

Key findings regarding bridging the know-do gap include the need for:

- A space/platform that bridges the gap between researchers and decision-makers, by fostering dialogues to better understand the duties and responsibilities of stakeholders. A 2020 study showed that not even 50% of African countries had knowledge transfer platforms in place and several challenges impacted the functionality of these platforms, including inadequate funding and lack of dedicated personnel (Asamani and Nabyonga-Orem 2020).

- Initiatives such as the WHO "Evidence-Informed Policy Network" (EVIPNet) (World Health Organization 2016) in Africa and the Region of East Africa Community Health (REACH) Policy Initiative were funded in the previous EU-FP7-Health programme and contribute to evidence-based policies, as well as the SURE project. (Supporting the use of research evidence (SURE) for policy in African health systems 2014).

- Integration of research into health systems. Research findings should inform policy and implementation, to improve health systems, as science is essential for policy making. The AUDA-NEPAD report on the research-policy nexus (African Union Commission 2018) highlights the COVID-19 pandemic as a driver for the emergence of research hubs, communication, advocacy, and harnessing of scientific results to inform policies on the African continent.

- Ownership and transparent leadership by African researchers for R&D projects.

- Donor grants and projects to be co-designed, aligned and integrated with existing national plans.

- Using digital technologies and information systems as a means to accelerate the translation of research results into policies and into health products and services. Promoting data transparency and interoperability was underscored as essential for bridging continental research and policy gaps.

- Collaboration and communication between the public and private health sectors. The private sector plays a major role in healthcare provision in many countries, and helps transfer new knowledge
and innovation, release usable products, and ultimately improve health and development across the continent.

- Private providers need to be involved in the policy dialogue as countries aim to transition away from fragmented care. Fragmentation in the provision of health services and funding reduces risk pooling and the efficiency (and effectiveness) of public health spending; widening risk pools is key to reducing the impact of ill health on the most vulnerable communities and individuals, and more research is needed into best models on the African continent.

**2.4.4. Thematic health priorities**

A strong public health system, enforced by vertical programmes based on the needs of countries, is key to UHC, built on strategic planning and health systems governance, health financing and effective development cooperation.

Health research priorities have to be based on local health needs, strengthening public health systems and pandemic preparedness. The thematic priorities should be driven by the global goal of UHC, the unfinished MDG agenda (major health issues including women and child health, HIV, malaria and tuberculosis) and the SDG framework (addressing issues such as adolescent health and wellbeing, non-communicable diseases (NCDs), mental health, nutrition and neglected tropical diseases (NTDs, target SDG3.3).

There is a need to establish Networks of centres of excellence focusing on Communicable and NCD, both frequent in Africa (e.g. cancer, hypertension and sickle cell anaemia). These disorders call for a multidisciplinary approach. Having a strong clinical and research community would make it possible to make existing treatment available to any patient in Africa (and the output is measurable). Such centres can act as a nucleus in which expertise is built up. They can also advise and influence regional and national policies and serve as an example for other fields of medicine.

The EDCTP platform has shown the impact of several networks and centres of excellence in R&D of capacity in the field of HIV, malaria and tuberculosis. This is another example of the R&D landscape for neglected diseases that evolved significantly, leading to the launching of new R&D initiatives by a broad range of actors, including academic groups, pharmaceutical companies, governments from emerging economies, and others. One of the results of this evolution is the not-for-profit product development partnerships (PDPs), such as the “Drugs for Neglected Diseases Initiative” (DNDI), which aims to fill R&D gaps and catalyse new scientific projects to address the needs of neglected patients (DNDI 2019).

New areas include the study of the microbiome in Africans, to understand adaptation to diet and environmental influences on host-microbiome interactions (Ramsay et al. 2011); reinforcement and support of “omics”/genomic medicine and gene-driven technology, and precision medicine (African Academy of Sciences 2021a), in line with the AAS/AUDA-NEPAD action plan.
2.4.5. Progress made on R&I policies, developments and activities in the African-European context in health systems

During the past two decades, the prominence of health policy and systems research has grown. It has shifted from disease or service-specific ways of health services in LMICs towards a more integrated and system-focused perspective, embodied both in UHC and in the SDGs, considering the equity and human rights framework for health, and accountability.

While substantial progress has been made, a number of outstanding challenges and opportunities remain. Increasingly, the need is acknowledged for rigorous comparative analyses that help understand which interventions work best in specific contexts and fuel shared learning across countries.

AU-EU cooperation has been the fruit of a long evolution of complex ties between the two regions that is rooted in history and proximity. This cooperation is framed by a number of policies. While initial partnerships between the continents focused on trade and development, from the Lomé Convention in 1975 to the Cotonou Agreement in 2000, there has been a gradual shift towards contemporary challenges in food security, health and climate change (European Commission 2021c).

Indeed, there have been long-lasting political relations between the two, as outlined below:

- **EDCTP** is the most cited joint programme strengthening health research and health systems in Africa. This programme was created in 2003, and is the flagship EU-Africa partnership in health R&D cooperation, with large successful long-lasting research networks. Since 2014, EDCTP2 has allocated EUR 608.6 million in 217 clinical studies, including 130 clinical trials. The European Commission will have additional calls for projects in global health from 2022, as part of EDCTP 3.
These will include an EU-Africa Global Health Partnership proposal with the EU budget contribution standing at EUR 800 million plus an expected EUR 400 million from other sources.

- The 2007 **Joint Africa-EU Strategy (JAES)** was a jointly agreed strategy between Africa and the EU based on the principle of a partnership of equals. JAES focused on eight thematic partnerships that extend beyond traditional spheres of aid and development. These partnerships had specific, jointly agreed action plans attached to them for 2008-10. JAES was designed to enable the EU and Africa to adopt a common position on certain global issues. There is a central role for the African Union and its Commission (Tywuschik and Sherriff 2009). JAES prioritised health research as a means of addressing global challenges and common concerns related to HIV/AIDS, malaria, tuberculosis and other pandemics. It also called for research to be supported on vaccines and medicines for major, neglected and waterborne diseases.

- In 2010, the European Commission presented a Communication – The **EU Role in Global Health** – mainly focusing on democratic and inclusive global health governance, ensuring universal health coverage, creating policy consistency and investing in research that benefits all. This is regarded as a milestone for the EU’s commitments to global health despite the gap in systematic translation of strategic documents into sustained political action (The Global Health Centre 2020).

- Establishment of **Regional Centres of Regulatory Excellence (RCOREs)** in Africa in 2014, which are centres that seek to strengthen regulatory capacity development in Africa. AUDA-NEPAD, through its AMRH Programme, has designated 11 RCOREs with eight different functions: pharmacovigilance, training, quality assurance, medicine evaluation and registration, evaluation and clinical trials oversight, and licensing and surveillance of medicine manufacturers. The AMRH also supports the regulatory workforce that promotes human and institutional capacity and contributes to improved healthcare delivery, regulatory standards, and practices in Africa. The AMRH is an AU programme that has been implemented as part of the Pharmaceutical Manufacturing Plan for Africa (PMPA).

- In 2017 the **HLPD** defined the priority areas for research cooperation to support implementation of the JAES. Projects and results coming from this include the research project database (CORDIS) and the Horizon results platform where EU-funded projects in partnership with African researchers and institutions, among others, showcase their results.

- The **Africa Centres for Disease Control and Prevention (ACDC)** - established in 2017, is a specialised technical institution that advises the AU and African countries on strengthening the capacity of their public health institutions. The centre has led Africa’s response to the current pandemic by developing a joint continental strategy and continental taskforce on COVID-19. ACDC facilitates data sharing by countries and provides real-time insights into the evolution of the pandemic across AU countries (Massinga Loembé et al. 2020).

- The **ECDC-ACDC collaboration** (European Union and African Union 2020) on epidemic preparedness and response is a four-year EU-funded partnership initiative to strengthen the capacity of African CDC to prepare for and respond to public health threats in Africa. The project

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8 Implementation of the JAES was originally defined according to eight themes: peace and security; democratic governance and human rights; trade, regional integration and infrastructure; MDGs; energy; climate change and environment; migration, mobility and employment; and science, information society and space.
aims to facilitate standardised surveillance and disease intelligence, and support implementation of the African CDC’s public health workforce strategy.

- The EU’s African Research Initiative for Scientific Excellence (ARISE) pilot programme 2019 promotes science, technology and innovation as critical drivers of development and sustainability. With the strategic guidance of the EU and AU, it aims to boost and further unlock Africa’s potential for innovation by supporting the next generation of scientific leaders. The EU is contributing EUR 25 million to the programme (European Commission 2021b).

- AUDA-NEPAD, through the 2019 African Science, Technology and Innovation Priorities (ASP) programme, has convened a team of scientists and policymakers to review governance issues relevant to Africa concerning the use and reuse of data and bio specimens from African sources, and develop guidelines and practical recommendations for data and bio specimen governance on the continent (African Academy of Sciences n.d.b).

- The 7th and 8th EU research framework programmes (FP7 and Horizon 2020) have supported and helped build capacities for health systems in Africa. The health programmes and topics targeting Africa were aligned with the general policy of supporting national health systems. This is also the case for the Europe Aid programmes that supported national health systems under bilateral agreements with African countries.

- The Team Europe Initiative (2021) on manufacturing and access to vaccines, medicines and health technologies in Africa will help create an enabling environment for local vaccine manufacturing in Africa and tackle barriers on both supply and demand sides, backed by €1 billion from the EU budget and European development finance institutions such as the European Investment Bank (EIB) (European Commission 2021a).

- The Partnerships for African Vaccine Manufacturing (2021), launched by the ACDC and the Team Europe initiative, are set to develop regional manufacturing hubs in South Africa, Senegal, Egypt, Morocco and Rwanda (African Union and Africa CDC 2021). The partnership will facilitate vaccine production in Africa to address COVID-19 and other diseases.

2.4.6. Cross-cutting issues

Given the interdisciplinary nature of this project, the health systems AG works in tandem with the three other AGs (strengthening R&I capacities in Africa for regional and bilateral cooperation, innovation and technology revolution and green transition in Africa).

The AG identified several cross-cutting issues identified for all four AG topics:
2.5. LESSONS LEARNED & POLICY RECOMMENDATIONS

To make progress on AU-EU health priorities via R&I the following are policy recommendations structured around the main priority areas introduced in the previous sections of this policy brief.

2.5.1. R&I capacity building in health & health systems

R&I is a key driver of social and economic development with enormous transformational potential in the health area. To strengthen and leverage the sustainability, efficiency and impact of Africa-EU R&I in health cooperation, major shifts in paradigm are needed. Recommendations with regard to capacity building in R&I in health and health systems are:

- Strengthen health research capacity in research institutes as well as users of research data, (including governments and health policy/decision-makers) that is key in developing health systems and epidemic preparedness.
- Expand and empower health R&I networks, including all relevant constituencies, based on equity, and agendas driven by local, national and regional needs. Co-creation is important, not only at
implementation level but in the design development phase, based on public and socio-economic needs on the continent. Furthermore, to have a real-life impact, it is imperative to ensure community engagement in the design of studies, to allow better uptake of new or improved products or interventions. promote more transparent and inclusive engagement of communities and stakeholders in prioritising, implementing and monitoring health R&I programmes and projects.

- Expand programmes such as EDCTP and ARISE that support African researchers, and offer quality training and career development opportunities to large numbers of early and mid-career African scientists. Investment in individual career pathways is a start, but institutional research capacity strengthening is the way forward to have a long-lasting effect. Promote effective information and data sharing and collaboration, to allow meaningful engagement with peers and experts in one's field of research, speeding up product development, and informing public policy.

- Encourage the creation of more EDCTP-modelled collaborations in other priority areas of health cooperation that complement and maximise the impacts of the EDCTP, thus creating a more sustainable and enabling environment for health R&I in Africa.

- EDCTP is a unique model for collaboration, equal partnership and true co-ownership of strategy and activities between Europe and Africa. It has established a well-defined niche in global health, with a clear focus on later stages of clinical evaluation and adaptation of interventions for underserved populations.

- Promote constructive research partnerships between African and European countries and institutions, based on more inclusive and better institutionalised frameworks (Botti et al. 2018). Promote a more enabling environment for research and manufacturing of health technologies on the continent. This could be done by following the EU for health security in Africa: ECDC for Africa CDC cooperation mechanism of the EU and Africa CDC (European Union and African Union 2020).

- Promote open access and interoperability of data between the two regions. Promote open science principles in African R&I and encourage publications available in open access and making research data as open as possible and only as closed as necessary (European Commission n.d.b).

- Further promote gender equality and diversity in science policy via programmes supporting women and minority groups in science. With Horizon Europe, the European Commission reconfirmed its commitment to gender equality in R&I, and requires a Gender Equality Plan (GEP) in all public bodies, higher education institutions and research organisations wishing to participate in future calls (with a deadline in 2022 and beyond) under Horizon Europe. African research organisations and Horizon Europe should be encouraged to act for increased gender equality in R&I (European Commission n.d.c).

- Identify synergies and encourage funders to work in a more coordinated manner and break silos. Valorisation of research efforts is an important lever to create more impact. This requires the participation of all stakeholders and end-users and connecting partners on the ground to maximise investments and impact. There is a need to address the challenges posed by short-term and earmarked grants, as well as overly complex legal frameworks, including, in the case of product-development focused R&I, by moving towards flexible and long-term portfolio approaches aimed at reducing the risks of failure in R&I collaborations for product development and accelerating the clinical development of the most promising health tools.
• Consider the principle of co-funding between EU and African countries as in the EDCTP model; even minor or in-kind contributions by African institutions to increase ownership of research, development and innovation by the African research community.

• Translate continental strategies such as STISA-2024 into national implementation plans. National research plans and strategies are needed to discuss with donors and stakeholders, with coordination at both continental and national level.

• Further develop capacity to conduct clinical trials in African countries, building on the EDCTP model. Early support to launch the initiative (ANTICOV) was provided by EDCTP under its Covid-19 emergency call through a coalition aimed at identifying one or two treatments that could be used to treat mild and moderate cases of COVID-19 (EDCTP 2019b). A collaboration for creating clinical trial networks could be envisioned with the EU Covid-19 trials under the European COVID-19 adaptive platform trial network.

• Design key performance indicators to measure the impact of research cooperation in Africa. For example, monitoring and evaluation requirements are often set by donor reporting requirements and do not capture developmental goals set by regional or national guidelines. There is a need to incorporate findings from African science, technology and innovation prioritisation programmes into EU and AU programme designs and align public and private funding.

• Develop capacities on health and research in EU delegations to improve the consistency, alignment and effectiveness of EU initiatives in Africa. The HLPD should regularly organise events and consultations to discuss with officials and stakeholder the design, implementation and impact of EU-Africa cooperation on R&I, based on sound key performance indicators (KPI) and regularly publishing data and studies in this area.

• Improve coordination among donor agencies, multilateral organisations and research funders, with oversight by national governments to increase the efficiency and impact of global and local research.

2.5.2. Ethics and regulatory environment

Recommendations with regard to ethics and regulatory environment are:

• Strengthen and promote collaboration between national ethics committees and national regulatory authorities to facilitate long-term development plans towards regional alignment goals (EDCTP 2019a). This includes transferring promising and successful innovative systems and/or technologies from other regions, outside Africa and within Africa, to promote national and regional collaboration among these bodies.

• Support the establishment of AMA to promote regulatory strengthening, convergence and alignment while providing technical assistance to African national regulators. Align and standardise ethics and regulatory frameworks proposed by AMRH, AVAREF, and Article 58 of the EMA, and provide training and support for ethics committees. Promote the implementation of the ‘AU model law on medical products regulation’ via AMA (AUDA-NEPAD n.d.) at continental level (Ncube et al. 2021).

• Establishing ethics and regulatory frameworks in Africa could follow a region-by-region approach by cataloguing national-level legislation across African countries and building a matrix for all countries. This could describe personal data protection through legislation, e.g. health acts, access
to information acts, and acts protecting vulnerable populations. Finally, these initiatives could be aligned with the GDPR but adapted to the African context.

- Facilitate the ethical use and reuse of data and bio specimens, for the benefit of Africans. Promote a participant-centric approach for research involving human participants. Enable ethical research practices in Africa and provide governance guidelines by engaging political and institutional leadership, funders and researchers to ensure intersectional accountability and to promote ethical research translation and innovation in Africa (African Academy of Sciences 2021b).

- Facilitate quality control, certification and accreditation of ethics and regulatory bodies, and adherence to common international standards.

2.5.3. Bridging R&I and policymaking mechanisms; the ‘know-do’ gap

Most health system interventions that have been demonstrated to be cost-effective are hardly ever implemented, especially in LMICs. Some of the challenges faced in LMICs with regard to applying research evidence include the weakness of the health systems, the lack of professional regulation and a lack of access to evidence-based policies and practices. The lack of rigorous evaluations of implementation strategies also reflects in part the low priority accorded to health and systems research. **Recommendations** include:

- Strengthen institutions and mechanisms to allow systematic interactions between researchers, policymakers and other stakeholders who can influence the uptake of research findings, and invest in knowledge synthesis and translation. In this way, policymakers can use research evidence to justify decisions and, in turn, research findings may also gradually spread themselves into the language and concepts used in policymaking.

- The African Task Force for Coronavirus (AFTCOR), a pan-African science and policy engagement project on response to COVID-19, provides a blueprint (African Academy of Sciences n.d.a) for achieving consensus on complex technical and policy issues by convening stakeholders from the continent, including scientists, researchers and policy makers and senior government officials, for consultations on specific COVID-19 countries, regional and continental-level issues requiring rapid research synthesis and policy briefs to inform the countries’ response.

- Help civil society and patients participate in designing, implementing, monitoring and evaluating health R&I policies. For example, in the AU-EU High-level Policy Dialogue on Science, Technology and Innovation and other relevant platforms. Health and health systems research policies and interventions should be adapted and scaled up in ways that are accessible and fair at community level. To achieve this, it is crucial to address any contextual barriers and use factors that enhance policy uptake via implementation science.

- Fewer pilots and more long-term plans are needed to bridge the health/knowledge and policy gap.

- Research creates knowledge for development, and development demands evidence. Therefore, research partners need a seat at the table of development partners, and development decision-makers need easy access to data and knowledge.

- Invest in global and regional science and health diplomacy.
2.5.4. Synergies with existing policy bodies and initiatives

There are several global health initiatives aiming to strengthen and support health systems in Africa. Aligning AU-EU efforts at continental, regional and national levels with existing bodies is crucial for the sustainability of projects and continuity of policies.

The section below outlines global alliances and initiatives that will give programming the potential to create synergies:

- **Global research collaboration for infectious disease preparedness** - international collaboration of funders to support research on significant outbreaks of infectious diseases.

- **Global alliance for chronic diseases** - an alliance of health research funders focused on implementation science that examines how health interventions can be adapted and scaled up in ways that are accessible and equitable in low- and middle-income countries and in indigenous populations.

- **Coalition for Epidemic Preparedness Innovations** - to support the development of and access to vaccines against emerging infectious diseases.

- **Joint Programming Initiative on Antimicrobial Resistance** - a ‘one health’ antimicrobial resistance partnership.

- **International Rare Diseases Research Consortium** - the vision of this initiative is to enable all people living with a rare disease to receive an accurate diagnosis, care, and available therapy within one year of coming to medical attention. It is important for African rare-disease research and clinical-care infrastructure to be developed, promoted, and internationally and globally integrated.

- **International Consortium for Personalised Medicine** - this consortium has been supported by "Building links between Europe and Africa in Personalised Medicine", a Coordination and Support Action (CSA) funded by the EU through Horizon 2020.

- The **Comprehensive Strategy with Africa** (2021–2040) - launched in March 2020, this communication proposes the basis for a new strategy between the EU and the AU, addressing new prospects and challenges emerging from economic, political, social, technological, demographic, climate and environmental changes. Policy dialogues have since taken place to reinforce the strategic objectives, more specifically in strengthening African-European cooperation through partnerships in five key areas: green transition; digital transformation; sustainable growth and jobs; peace and governance; and migration and mobility.

- **Global Approach to R&I** (2021) - this is set on developing a joint AU-EU innovation agenda. This new strategy calls on the EU to support joint international R&I partnerships and aims to deliver innovative solutions to green, digital, health and innovation challenges. Following a set of concrete measures, the Global Approach seeks to respond to today's global context and align the EU's international cooperation with its current political priorities.

- **EU R&I programme Horizon Europe** (2021–27) - this programme targets international cooperation actions with key partners on strategic thematic areas. Participation by African countries is encouraged in projects funded under the Africa Initiative, launched under Horizon Europe in June 2021.

- The **Africa Initiative** is the immediate outcome of the first ever AU-EU R&I ministerial meeting in July 2020. This initiative is in the first work programme of Horizon Europe 2021–22 and aims to
strengthen long-term cooperation in finding solutions to enhance global public health, socio-economic development, and recovery from the COVID-19 pandemic. The total budget allocated for this initiative is EUR 350 million through 36 calls for proposals targeted at EU-Africa R&I cooperation, responding to four joint policy priorities, of which public health will receive an allocation of EUR 40 million. The budget allocated for Horizon Europe is EUR 95.5 billion (2021-2027) including EUR 5.4 billion from Next Generation EU, the EU programme for recovery from the COVID-19 crisis.

- **Neighbourhood, Development and International Cooperation Instrument (NDICI)** - this fund is to be applied as part of EU international activities. The NDICI has a substantial part devoted to strengthening R&I in Africa, both at regional and national levels. The overall budget is EUR 80.59 billion with at least EUR 29.18 billion specifically for sub-Saharan Africa.

- **WHO-TDR Strategic Initiative for Developing Capacity in Ethical Review (SIDCER)** - this consists of a network of independently established regional forums for ethical review committees, health researchers and invited partner organisations. The primary objective of SIDCER is to help protect human subjects globally by developing local capacity for ethical review of research involving human subjects and for developing policies on the ethics of health research.

- Establishment of African Vaccine Regulatory Forum (AVAREF) in 2006 by the WHO to address the changing landscape of biomedical research and product testing. The objective of this regulatory platform is to promote human resource capacity, best practices, common technical requirements and the efficiency and transparency of regulatory processes. This informal capacity building platform aims to improve the regulatory oversight of interventional clinical trials being conducted in Africa. It brings together national regulatory authorities and national ethics committees on the African continent with the objective of strengthening clinical trial regulation in Africa.

- **Pan African Clinical Trials Registry (PACTR)** - the first WHO-recognised clinical trials registry in Africa. PACTR aims to be a comprehensive database of planned, ongoing or completed clinical trials in Africa. It provides accessible information that describes the scope, location, ethics and funding patterns of trials conducted across Africa. The PACTR registry facilitates understanding of regional research patterns, enables the identification of research gaps for future studies, and facilitates the investigation of the scope, quality and funding patterns of African trials.

- The **OACPS-EU Partnership Agreement** (Organisation of African, Caribbean and Pacific States) 2021 sets the political, economic and sectoral cooperation framework for the next 20 years. Some of the key priority areas include human development (which encompasses health, education and gender equality), environmental sustainability, climate change, sustainable development and growth, and migration & mobility. The new agreement is set to be a powerful tool to advance the UN 2030 Agenda and SDGs.

- **Global EU response to COVID-19**. This Communication aims to support healthcare systems and the response to the pandemic in partner countries, thus strengthening the preparedness and response capacities of these countries. This includes strengthening regional epidemiological surveillance and disease control institutions in Africa (Africa CDC and its regional centres).

- **European and Developing Countries Clinical Trials Partnership (EDCTP)** - a successor to EDCTP2 is anticipated as from late 2021/early 2022 with the Global Health EDCTP3 Joint Undertaking. It will have a total budget of 1.6 billion Euro, 800 million Euro coming from the
Horizon Europe budget and 400 million Euro each are expected to come from participating countries and from additional partners such as foundations or industry.

- The AU Agenda 2063 - this long-term 50-year development trajectory for Africa identifies key activities to be undertaken in its 10-year Implementation Plans, which will ensure that Agenda 2063 delivers both quantitative and qualitative transformational outcomes for Africa’s people. Unfortunately, African countries are facing enormous challenges in terms of working on the measurability of the targets and also developing the statistical capacity required to collect the data to measure the targets set down by Agenda 2063.

- The Science, Technology and Innovation Strategy for Africa (STISA-2024) defines a new era for R&D in Africa. Through its four mutually reinforcing pillars, which are prerequisites for harnessing science, technology and innovation, STISA calls for a stronger, dynamic and more sustainable research enterprise in all development sectors, capable of translating scientific discoveries into products, services and processes.

- The Africa Health Strategy (2016-2030), adopted in line with the AU Agenda 2063 and SDGs, recognises the importance of investment in R&I for tackling the challenges with which the African continent is grappling.

- The AU Specialised Technical Committee on Health, Population and Drug Control (STC-HPDC) mandated AUDA-NEPAD, in collaboration with other interested partners, to facilitate the integration of R&I in the updated AHS strategy 2016-2030.

- Gaps that informed this strategy include poor financing of health research and health systems, lack of South-South collaborations, human and infrastructure capacity, skills and knowledge management and the global recognition of African research and researchers.

- STC-HPDC also identified several opportunities in integrating emerging technologies, the global interest in strengthening Africa’s health systems, the changing disease profile with an increase in non-communicable diseases and innovating financing models that were highlighted, which provide a platform for AU member states to build on for implementing the strategy.

- The authorities – through the ACDC – and EDCTP signed a Memorandum of Understanding in September 2021 aimed at establishing a framework for cooperation in their shared goals to promote a new paradigm in health. The AU and EDCTP will cooperate to implement a programme of work for the execution of activities within the following themes: Emerging and re-emerging infectious diseases, epidemic intelligence and capacity building for preparedness and outbreak response. The Memorandum additionally covers implementation and public health research, the one health approach, and data management.

### 2.5.5. Roadmap

R&I should be "in the DNA" of development programs, where research partners are needed for implementation, monitoring and evaluation as well as feeding data for improving, adapting local realities, scaling up and continuously looking for improvements and innovations.

Coordination and support measures are needed to create synergies for future activities in a co-constructive way between AU and EU. This will facilitate coordinated surveillance and disease intelligence, and support the implementation of Africa CDC’s strategic agenda to improve surveillance, emergency response and prevent infectious diseases, as well as strengthening health systems in collaboration with the WHO, member states, stakeholders and partners.
This roadmap proposes measures to implement AU-EU cooperation in health systems.

1. Co-creation of science, innovation and research agendas based on African health priorities and local needs, with investment in African institutional capacity building, leadership, and ownership, in alignment with existing bodies such as EDCTP, ACDC, WHO-Afro and AAS. The AAS African programme on scientific priorities (African Academy of Sciences 2020), developed by African research and science leaders, sets out a roadmap with priorities including maternal, neonatal & child health, genomics & precision medicine, climate change, data & bio specimen governance (African Academy of Sciences 2021b), food & nutrition security, epidemic preparedness & global health security, mental health, education & science, gender and diversity, based on equity and respect.

2. Building on synergies with other research in health programmes:
   - Develop a joint agenda for health and health systems R&D, led by national governments, with all stakeholders involved.
   - Rolling out the EU’s new global approach to cooperation in R&I to identify new opportunities and challenges in the field of public health, including resilience and pandemic preparedness, in particular after COVID-19. Following up on the Commission’s 2021 Communication will improve the consistency and effectiveness of EU and EU Member State health initiatives in Africa, and provide the basis for the development of a real AU-EU partnership in health.
   - Strengthen and support the transformation of R&I outputs into products and services with a concrete impact, and with investment in business development and access to finance for innovators.
   - Close collaboration with other sectors looking at cross-cutting areas, challenges and opportunities.

3. Promote open and inclusive approaches to R&I for health systems:
   - Equal partnerships between the two regional bodies. Definition of timelines and milestones according to existing policies e.g. Agenda 2063 (long-term), AAS Scientific Priorities (medium-term), Horizon Europe (short-term).
   - Co-creation, co-design and co-funding of programmes. Implementation of collaborative arrangements and financing mechanisms. Consider some principles upheld by the “Global Fund”, which is a financial instrument, not an implementing body, making available and leveraging additional financial resources based on programmes that reflect national ownership and respect country-led formulation and implementation processes.
   - Efficient sharing of data and information between the AU and EU.
   - Promotion of open science principles in R&I.
   - Equity in R&I between African and European researchers and institutions in terms of leading research programmes, not only at an individual level (principal investigators) but also institutional coordination and leadership, to be based on skills, capacities and merits, not on geography.

4. Focus on impact orientation by:
   - Developing shared concrete objectives for AU-EU health systems cooperation in the priority areas identified in this policy brief. Identifying policies and funding gaps and opportunities in EU-Africa
cooperation on health R&I, with attention to implementation research, knowledge synthesis, translation, and M&E. Partnerships should complement initiatives such as the EDCTP and help create a more enabling environment for health R&I in other priority areas that are not covered – or fully covered – by the EDCTP. These include population health, antimicrobial resistance (AMR), zoonotic diseases, mental health, women, child and adolescent health, sexual and reproductive health and rights, non-communicable diseases, neglected tropical diseases, nutrition and other health priorities in the SDG agenda.

- Identifying and aligning targets with key performance indicators, and agreeing on indicators such as the WHO national health research systems barometer.

- Having a platform for governance, and a monitoring, evaluating and learning structure for the proposed activities.

5. Encourage active involvement of member states and relevant stakeholders from all countries. Expand R&I in the EU programming of development aid (e.g. NDICI – Global Europe instrument) by involving researchers, innovators and other relevant actors in the process.

6. Further development of ‘hybrid-blended’ financial instruments with increased domestic funding, and external finance instruments for research in health.

7. Incorporate gender and diversity aspects into research programmes, as a prerequisite for institutional support and collaboration.

The following concrete measures are proposed for short term programming according to the identified priority areas:

**R&I capacity building for health systems**

Capacity building for research institutes and networks of excellence, as well as of users of the research data, in R&I in pre-identified and future priority areas that will be set with AU institutions. Priorities identified by the AG health group include:

1. Co-design and co-creation of R&I based on equity

   - Epidemic preparedness and response: health systems preparedness sustainability and resilience, support vaccination manufacturing and genomic driven pathogen surveillance.

   - Trans-disciplinary investigation of specific disorders relevant to Africa for fulfilling the unfinished MDGs and the SDG priorities: women, child and adolescent health, infectious diseases and NCDs, mental health, NTDs, and specific disorders relevant to Africa. This should be coordinated with existing global initiatives, as mentioned in section 4.2.

   - Precision medicine and precision public health in Africa: think tank drawing on previous experience, in particular from the H3Africa projects, on the best way to implement precision medicine in Africa. There are currently emerging centres of Excellence paving the way to precision medicine in Africa in various countries (South Africa, Kenya, Nigeria, Senegal, Tunisia etc.). As well as supporting these Centres of Excellence, there is a need to support ‘sentinel labs’ to ensure wide coverage of the various geographical regions and populations, to promptly reply to health needs on the African continent.

   - Networks of Excellence.
2. Develop ‘hybrid-blended’ financial instruments with increased domestic funding, and external finance instruments for research in health

3. Establish platforms for monitoring, evaluating and learning

4. Develop capacities on health and research in EU delegations. This is critical for improving the consistency, alignment and effectiveness of EU initiatives in Africa.

Ethics and regulatory environment

1. Support AMA in its future missions, in particular strengthening and networking between the national regulatory agencies.

2. Support the strengthening and alignment of African ethical and regulatory frameworks at regional and continental level, in collaboration with EMA.

3. Strengthen platforms and training opportunities supporting African ethics committees and the research community via AU-EU Projects.

Bridging the gap between R&I policies and health intervention

The know-do gap remains substantial and more is needed to make a difference, by investing in the field of science and health diplomacy, accountability frameworks, leadership and strong partnerships with local and global sustainability frameworks, to achieve a long-term impact on health:

1. Invest and support implementation research projects and establish a monitoring and evaluation program to ensure a sustainable follow up.

2. Integrate research in the development program of health system strengthening as well as in higher education programs e.g. the AU-EU ERASMUS/NYERERE programme

3. Establish measures to support young and experienced researchers in their early careers, including incentives to avoid brain-drain, as well as institutional strengthening.

4. Prioritise the narrowing of the ‘know-do gap’ by investing in science & health diplomacy, accountability frameworks, leadership and strong partnerships with local and global sustainability frameworks, to have a long-term impact on health, based on health data and the SDG 3 priorities. Some interventions are not very resource heavy, but require long term investments, hence less pilots, more long-term plans.

5. Scaling and expanding proven successful models for AU-EU collaboration such as the EDCTP flagship programme in infectious diseases. The Global Health EDCTP3 will support the development of long-term equitable collaborative research partnerships that are based on respect and diversity, gender-balanced and inclusive of strong national commitments and leadership with ownership of African-led African-based research. More Networks of Centers of Excellence are needed to strengthen South-South and North South collaborations.
3. R&I CAPACITIES IN AFRICA

By Anneline Morgan and Barbara Dlamini

3.1. EXECUTIVE SUMMARY

This chapter focuses on cooperation between Africa and Europe in areas of R&I capacities at regional and bilateral level over the past 10 years (2012-2021). Policy options and recommendations were developed based on the analytical work conducted to inform and strengthen R&I cooperation between Africa and Europe within the framework of the new comprehensive strategy with Africa and future outlook of the partnership.

Methodologically, the study made use of qualitative and quantitative approaches, including surveys, as well as structured and unstructured virtual interviews, one virtual stakeholder engagement workshop and feedback raised during events related to the AU-EU R&I cooperation. Furthermore, case studies on existing R&I capacity programmes, projects and partnerships, mainly implemented within the framework of the AU-EU High Level Policy Dialogue (HLPD) were analysed.

The findings from the survey conducted for this study show limited awareness of the funding instruments under the AU-EU R&I cooperation and on the HLPD. Highlighting a need to increase the advocacy and awareness of the instruments and platform of the AU-EU R&I cooperation to encourage higher participation of African researchers in the EU framework programmes on research. Furthermore, it was shown that stakeholders participating and benefiting from programmes largely originate from academia and research and technology organisations, with only low representation from industry/private and public sector. This derives the need to improve the representation and diversity of sectors in partnership. At the same time, public universities produce most of the research output in Africa with 50-90% depending on the national contexts, hence they are strategic stakeholders for any targeted investment in the overall African R&I capacity, linked equally to society, students, and the economy.

The challenges that are constraining progress towards increasing R&D investment in several member states include inadequate infrastructure, lack of R&D human resources, and poor capacity of translating research into commercial outcomes. This leads to a dependency on government funding for R&I. Moreover, the business sector investment in R&D is lacking in several of the member states. Policy steps are required to improve the environment for higher levels of business sector R&D on the continent. Improvements in education, infrastructure and ICT, and closer alignment between research agendas and socio-economic challenges, are proposed as measures to enhance R&D and innovation on the continent.

Responding to the key policy frameworks and strategies by AU and EU and the findings of this study the following policy recommendations are proposed:

Strengthen R&I policy and governance by designing programmes to foster the policy capacities of science academies in Africa as independent think tanks and knowledge institutions. Improve the data-collection on R&I through capacity building programmes and strengthening the capacities of national statistical offices in member states. Support existing programmes coordinated by AUDA-NEPAD on R&I indicators and strengthen the human and institutional capacities of the AU observatory on STI. Encourage policy learning through policy dialogues and think tanks.

Investment in human and institutional capacities by setting up programmes to support Africa in drawing from lessons learned from the implementation of programmes such as Marie Sklodowska C Advocate for inclusivity in STEM by investing in programmes that target gender, people living with programmes targeting developing skills within the context of 4IR while establishing key networks with capacities at higher education institutions and research and technology organisations. Support emerging scientists, including the training of the next generation of science communicators and journalists.
disseminating research results. Design capacity building programmes to strengthen research ethics in the education and research organisations.

- **Strengthen innovation ecosystems, technology transfer and intellectual property (IP),** informal innovation and frugal innovations by designing capacity building programmes for SMEs in areas of technology transfer and IP-rights. Design incubation support programmes in key priority industrial value chains to boost small businesses and enterprises.

- **Investment in R&I infrastructures** to provide tools for scientists and researchers in advancing science.

- **Promotion of open and free access to scientific data and knowledge** to create a level playing field in North-South and South-South R&I cooperation.

- **Investment and promotion of digital transformation and emerging technologies** to advance scientific excellence and competitiveness and support inclusive development.

- Increased **investment in R&I funding** by strengthening existing R&I funding instruments and schemes and establishing new and flexible funding programmes at bilateral, regional and international level to diversify funding partners. An Africa education-science-fund should be established with pledges made by some of the member states

- **Foster international cooperation and partnerships in R&I** by strengthening existing partnerships and platforms and creating synergies with other bi-regional and multilateral partnerships and advancing inclusive and equal participation of women, youth and disadvantaged groups in all partnerships and programmes.

- **Strengthen governance mechanisms** of the partnership and create synergies with existing policy structures at AU and EU Commission.

### 3.2. STATE OF PLAY & PRIORITY TOPICS

This policy paper aims to review cooperation between EU-Africa in R&I capacities at regional and bilateral level. The study assesses the status of the cooperation between AEU-Africa in R&I capacities over the past 10 years. Policy options and recommendations are developed based on the analytical work conducted to inform and strengthen R&I cooperation between Africa and Europe within the framework of the new comprehensive strategy with Africa and future outlook of the partnership.

#### 3.2.1. Defining R&I

In order to approach the topic, a definition of R&I is first given. **Research** can be described as the generation of knowledge, while **innovation** is the use of knowledge to generate money or income. Innovation is further defined as the application of new solutions to address the needs or demands of existing markets or emerging requirements (Halme 2014). Innovation thus goes far beyond R&D and also goes beyond the confines of research labs linked to users, suppliers and consumers. Four types for measuring innovation are defined by the OECD: product innovation, process innovation, marketing innovation and organisational innovation (OECD 2018). The figure below illustrates the interaction of R&I in relation to knowledge and generation of income and money.
3.2.2. The evolution of the AU-EU cooperation in R&I

The African-European cooperation in R&I is built on the overall political and economic partnership between the two regions launched in 2000 during the first AU-EU Summit in Cairo, Egypt. Subsequent summits were held in 2007 (Lisbon, Portugal), 2020 (Tripoli, Libya, 2014 (Brussels, Belgium), 2017 (Abidjan, Ivory Coast). The sixth summit has been postponed due to the COVID-19 pandemic.

In 2007, the Joint Africa-EU Strategy was launched during the second AU-EU summit, followed by a first action plan in 2008-2010 and the second action plan in 2011-2013. They focused on the following key priorities: peace and security; democratic governance and human rights; regional economic integration, trade and infrastructure; MDGs; climate change and energy and migration, mobility and employment. Following the 2014-2017 action plan, the Abidjan Declaration was adopted with revised areas of cooperation: investing in people, education, science, technology and skills development; strengthening resilience, peace, security and governance; mobilising investments for African structural and sustainable transformation and migration and mobility. Both regions boost competitive and comparable advantages in the areas of trade, economic development and growth.

The AU-EU High Level Policy Dialogue (HLPD) on Science, Technology and Innovation is the forum where regular exchanges on R&I policy take place and long-term priorities to strengthen cooperation are decided. The HLPD was adopted at the third AU-EU summit as an important element of the JAES. Senior official meetings (SOMs) took place in 2012 (Cape Town, South Africa), 2014 (Brussels, Belgium), 2016 (Addis Ababa, Ethiopia), 2017 (Brussels, Belgium), 2019 (Addis Ababa, Ethiopia). An exceptional HLPD plenary took place virtually in 2020. Since 2017 the SOM is accompanied by the HLPD stakeholder forum as a support structure to enrich and guide the formal and informal processes of the bi-regional policy dialogue. The HLPD is further accompanied by three thematic roadmaps on: (1) food and nutrition security since 2016, (2) climate change and sustainable energy since 2017 and (3) innovation since 2021.

In 2020 a first AU-EU R&I ministers’ meeting took place. It focused on its newly agreed four priority R&I topics of the cooperation: green transition, innovation and technology, public health and capacities for science and higher education and its relation to socio-economic effects of the COVID-19 crisis and discussed short-, medium-, and long-term research and innovation interventions to alleviate the consequences of the crisis and economic recovery.

[Figure 4: Visualisation definition R&I (Jacić 2021)]
Policy frameworks and strategies have been developed to advance the African continent’s development and integration agenda.

The agenda 2063 is Africa’s blueprint to transform the continent as a major player in the global economy. It provides a framework for a common vision of an integrated, prosperous and peaceful Africa; an Africa driven and managed by its own citizens; and representing a dynamic force in the international fora. The agenda 2063 is based on seven aspirations and 20 goals, with goal 2 focusing on well-educated citizens and the skills revolution underpinned by STI. STI cuts across all the goals and has a key role to play in advancing the implementation and achievement of all other goals. Figures 6 and 7 depict Agenda 2063’s aspirations and goals.

The adoption of the agenda 2063 also coincided with the adoption of Africa’s common position on the post-2015 development agenda, which was framed into six priority pillars: (1) structural economic transformation and inclusive growth; (2) STI, people-centered development; (4) environmental...
sustainability, natural resources management, and disaster risk management; (5) peace and security; and (6) finance and partnerships.

The second cornerstone of the African R&I framework is **STISA-2024**. The strategy builds on the previous consolidated plan of action on science and technology and is a contribution and response to agenda 2063. The strategy is anchored in the following six priority areas: (1) eradication of hunger and achieving food security; (2) prevention and control of diseases; (3) communication (physical and intellectual mobility); (4) protection of our space; (5) live together – build the society; as well as (6) wealth creation.

The **African space policy and strategy** launched at the AU Summit in January 2016 marked an important step towards building Africa’s capacities for harnessing space science, technologies and innovations to respond to Africa’s priorities for growth and transformation, thereby boosting the African space economy.

In line, the long-term people-centered Agenda 2063 identifies an African space programme aimed at strengthening Africa’s use of outer space resources to bolster its socio-economic development and the need for Africa to emerge as one of the global players and as a responsible user of outer space. The African space policy and strategy envisages an African space programme designed to build space capabilities for earth observation systems, navigation and positioning, satellite communication and space science and exploration. The African space programme will be championed by AU member states and will provide a platform for an African space dialogue and intra-Africa and international cooperation to ensure optimal access to space-derived data, information services and products.

The African continent is at the embryonic stage of the **AfCFTA**. The launch of the free trade area in January 2021 paved the way for renewed economic cooperation within the continent and repositioned the continent’s partnerships with the rest of the global community in promoting mutual and balanced partnerships in trade. Given that the EU is its largest trading partner, its actions will have long-standing effects on the implementation of the agreement. Many African states still have to adapt their legislation and regulations to integrate the terms agreed upon. The EU’s reaction to the new African trade area will be a determining factor in the success of the AfCFTA. The **economic partnership agreement between the EU and the Southern African development community (SADC EPA)**, which regulates trade in goods between two regions, was signed in 2016. Since then, the EU has fully or partially removed customs duties on 98.7% of imports from South Africa, while guaranteeing full free access to the rest of the signatories (Botswana, Lesotho, Mozambique, Namibia and Swaziland). In the future it will be interesting to see how these African countries sustain their trade relations with the EU under the new AfCFTA in view of the existing policies that have a direct and indirect effect on R&I collaboration and the capacities or capabilities.

The figure below provides an overview of Africa’s development architecture.
From the European side the African efforts are supported by a series of policies. Already back in 1971, the European Economic Community along with 19 European countries established the **European cooperation in science and technology (COST) programme** to promote networks of researchers in Europe and beyond. Its objectives include capacity building by connecting high-quality scientific groups, offering networking opportunities for early stage researchers and increasing the impact of current research among policymakers, regulatory bodies and the private sector. While the programme may not fund research, it does sponsor the creation of bottom-up networks of scientists and researchers through its ‘COST actions’ – mechanisms to promote international coordination of nationally funded research and global cooperation.

In March 2020, the EU published the communication ‘**Towards a comprehensive strategy with Africa**’ presenting EU proposals in view of defining a joint partnership agenda with the AU at the sixth AU-EU Summit, scheduled for 2022. It proposed five EU-Africa partnerships: green transition and energy access; digital transformation; sustainable growth and jobs; peace and governance; and migration and mobility.

Moreover, the new **EU-OACPS Partnership Agreement** was initiated in April 2021. It substantially modernises and embraces R&I cooperation, extending the scope and scale of EU and OACPS ambitions to better address challenges and governance.

Furthermore, it is important to note that **EU trade policy** is the main proponent driving the EU’s interaction with other countries. It is important to understand how the EU is organised – the 27-member states share a single market and trade policy. According to Eurostat, EU member states speak and negotiate as a collective, whether with the World Trade Organization (WTO) or with individual trading partners (EUROSTAT n.d.). This enables the EU to communicate effectively in trade negotiations, maximising their impacts. This strategy is also important when implementing R&I agendas as their science engagements usually result in research ideas reaching the final stage – mainly the commercialisation of technology – and having large stakes of ownership when it comes to intellectual property. In this regard it can be said that R&I can be linked to trade and the economic development of developing countries, which stimulates economic growth.

The establishment of R&I consortiums has been a key instrument in how African researchers or partner organisations negotiate their project strategies for mutual benefit.

### 3.2.3. R&I cooperation programmes and partnerships

The R&I cooperation between the continents is accompanied by a series of cooperation programmes and partnerships aiming to boost R&I cooperation between Africa and Europe in the key priority areas of green transition, innovation and technology, public health and capacities for science and higher education as agreed upon at the first AU-EU R&I Ministers’ meeting in July 2020.

The following sections provide an overview of AU-EU cooperation initiatives in various sectors. Special focus is put on cooperation programmes and partnerships implemented within the framework of the HLPD as the main instrument of R&I cooperation between the continents. Chapter 3.2. will provide an assessment of the previous AU-EU cooperation in the R&I area in terms of its success, challenges and opportunities for future programming and support through the lessons learned and impacts made during the various stages of implementation.

The importance of **R&I-cooperation between the continents** is further underlined by a series of policies. Selected programmes and partnerships targeting Africa and Europe are described below.

One of the **overarching, flagship-programmes** supporting the EU’s R&I cooperation is the **Horizon Europe** programme. It has been allocated a budget of EUR 95.5 billion and will run from 2021 to 2027. The programme is divided into three pillars:

- **Pillar 1: excellent science** (European Research Council, MSCA, research infrastructure).
- **Pillar 2: global challenges and European industrial competitiveness** (health, culture, creativity and inclusive society, civil security for society, digital, industry & space, climate, energy and mobility, food, bioeconomy, natural resources, agriculture and environment).

- **Pillar 3: innovative Europe** (European Innovation Council, European innovation ecosystems, European Institute of Innovation & Technology).

Other components of Horizon Europe consist of the specific programme: **European defence fund** with an exclusive focus on defence R&D. The **EURATOM programme** with a focus on nuclear fusion and fission research and training. The **widening participation and strengthening of the European research area** cross-cutting pillar emphasises greater participation and the spreading of excellence as well as reforming and improving the European R&I system.

The **Africa initiative** is included in the first work programme of Horizon Europe and runs from 2021 to 2022. It has been allocated a budget of around EUR 350 million. It is the first outcome of the AU-EU ministerial meeting that took place in July 2020. It aims to strengthen long-term cooperation in finding solutions to improve global public health, socio-economic development and recovery from the COVID-19 pandemic.

The initiative comprises several calls for proposals covering 36 topics to be launched in 2021-2022. These target Africa-EU R&I cooperation, in line with the joint policy priorities:

- **Public health**: focusing on research on poverty-related diseases (PRDs) and the third iteration of the EDCTP: the Africa-EU global public health partnership.

- **Green transition**: focusing on R&I areas such as sustainable energy, food security, sustainable agriculture, biodiversity and climate change.

- **Innovation and technology**: focusing on areas such as raw material value chains, research infrastructure and support to innovation partnerships.

- **Capacities for science**: focusing on global governance, public policies for sustainable development and research ethics, and new technologies.
It is envisaged that there will be clear synergies between the Africa initiative and existing or future programmes supported by the EU. In the following an overview of selected running programmes is presented, highlighting the possibilities for combined efforts.

**The neighbourhood, development and international cooperation instrument (NDICI) – Global Europe**, will streamline and simplify the EU’s external financing instruments for international cooperation with partner countries. It will cover the European neighbourhood (including North Africa), Sub-Saharan Africa, Asia and the Pacific, and the Americas and the Caribbean. Among the many thematic areas, it will include Science, Technology and Innovation. The programme runs from 2021 to 2027. It has a budget of around EUR 80 billion, with at least EUR 29 billion earmarked for Sub-Saharan Africa.

In the area of **capacities for science and higher education** the following programmes frame the cooperation:

- **The Erasmus+ programme** supports education, training, young people and sport in Europe. The 2021-2027 programme focuses on social inclusion, the green and digital transition, and promoting young people’s participation in democratic life.

- **African research initiative for scientific excellence (ARISE)** focuses on talented early-career scientists who aspire to be leaders in their research fields. The programme is implemented through the African Academy of Science.

- **AU research grants** support competitive research programmes and facilitate intra-continental networks in R&I. The grants are financed in partnership with the EC and the ACP group of states under development and cooperation funding through the 10th European Development Fund intra-ACP envelope.

- **Kwame Nkrumah scientific awards** was launched in September 2008 to recognise scientific excellence at national, regional and continental level, financed in partnership with the EC.

In the field of **health**, the **European and Developing Countries Clinical Trials Partnership (EDCTP)** is the key programme. It is funded by the EU, with co-funding from associated members. It aims to reduce the social and economic burden of PRDs in developing countries and accelerate the clinical development of effective, safe, accessible, suitable and affordable medical interventions for PRDs in partnership with sub-Saharan Africa. The overall objective is to help reduce the social and economic burden of PRDs in developing countries, in particular in Sub-Saharan Africa, by accelerating the clinical development of effective, safe, accessible, suitable and affordable medical interventions for PRDs in partnership with sub-Saharan Africa. The initiative is an excellent example of a mutually beneficial Africa-EU partnership – it helps tackle the global challenge of PRDs and make progress on the SDGs.

In the field of **green transition** various programmes and partnerships support the R&I cooperation between the two continents:

- **The AU-EU R&I partnership on climate change & sustainable energy** supports renewable energy and energy efficiency initiatives as well as cross-cutting issues related to climate change and sustainable energy, such as human capital development, capacity building, open data and open access. To underpin the EU Green Deal and the AU’s Agenda 2063 on renewable energy, the long-term joint **AU-EU R&I partnership on renewable energy (LEAP-RE)** is key in ensuring the sustainable promotion of pathways for empowering local R&I, while improving the conditions for transforming research into effective innovation, tailored to specific societal needs, the capacities and aspirations in Africa, and acknowledging regional discrepancies. Some of the lessons learned could assist in further strengthening R&I capacities, partnerships and cooperation between Africa and the EU.
The **AU-EU R&I partnership on food and nutrition security and sustainable agriculture** addresses the challenges set out in SDG 2: end hunger, achieve food security and improved nutrition and promote sustainable agriculture, by stimulating joint AU-EU R&I activities for an initial period of 10 years. The partnership so far has channelled a joint investment of €381 million on four priorities: (1) sustainable intensification of agriculture, (2) agriculture and food systems for nutrition (3) expansion and improvement of agricultural trade and markets and (4) cross-cutting topics. The **long-term AU-EU R&I partnership food and nutrition security and sustainable agriculture (LEAP4FNSSA)** is a key element in achieving these goals. The focus areas support implementation of the following African and European policy frameworks of the EU Green Deal, comprehensive strategy for Africa, STISA 2024 and comprehensive Africa Agricultural Development Programme. For the future trajectory, the FNSSSA platform is conceptualising an international research consortium.

**Development smart innovation through research in agriculture (DeSIRA)** was launched by DG INTPA in 2017 with the aim to foster innovation through research to contribute to transformation of agriculture and food systems in low and middle-income countries. The DeSIRA objectives are framed around the following three pillars: (1) support innovation in agriculture for sustainable agriculture and food systems (productive, inclusive, climate sensitive), (2) strengthen research capacities and governance mechanisms for improved agricultural innovation systems and enhanced evidence for innovation and advisory policies and monitoring.

**Global monitoring for environment and security (GMES) & Africa** is a space component programme of the Africa-EU partnership and was launched in 2007. The programme aims to facilitate collaboration between Africa and Europe in the area of earth observation to respond to global challenges and to manage the environment and climate change.

Two other notable projects that contribute to AU-EU R&I cooperation in the space field include the **pan-African planetary and space science network**, an intra-Africa mobility project funded by the EU through the European Education and Culture Executive Agency (EACEAN), and **Europlanet 2024** funded by Horizon 2020. Europlanet is the largest planetary science infrastructure in the world that promotes collaboration among scientists in the field and includes African partners (Botswana and Ethiopia).

AU-EU cooperation in **innovation and technology** is further supported by:

- The innovation partnership was welcomed as the third AU-EU R&I partnership during the 5th HLPD SOM in 2019. It highlights the importance of innovation within a broader partnership, the cross-cutting nature of innovation and its potential for the creation of sustainable growth, development, jobs and thus stimulating entrepreneurship. The new partnership as a critical framework to foster collaborative alliances and relationships between the continents.

- ACP innovation fund is a key component of the OACPS R&I programme. It aims to strengthen R&I capacity in its ACP member countries, unlock their innovation potential and support their transition to knowledge-based economies for sustainable development.

However, **R&I-cooperation** does not only play a crucial role in overall AU-EU cooperation, but also at the **regional level**. Selected programmes by the Finnish government targeting the R&I cooperation with Africa are described as an example for regional cooperation.

The selected regional cooperation programmes address various topics such as **green transition, innovation and technology or capacity building**.
• The energy and environment partnership programme in Southern and East Africa (EEP S&EA) provided co-financing to projects through feasibility studies aimed at investments as well as pilot and scale-up projects in the area of energy. It also supported knowledge exchange forums in the fields of renewable energy and energy efficiency. The programme received EUR 40 million in funding between 2013-2017, with co-financing from the Finish Government, the UK department for international development and the Austrian development agency.

• Finland, NEPAD and SADC-member states supported the Southern Africa network for biosciences (SANBio) in promoting regional development by strengthening biosciences capacity and bringing new innovative products to the market. The network supported research networks of universities, research institutions, NGOs and other organisations in 13-member states of the region. The steering committee oversees the implementation of the network programme activities and monitors the annual work plans to ensure alignment with regional STI priorities, agriculture and health and replication of outcomes in the rest of the region through knowledge and policy exchange workshops and projects. It also provides strategic guidance and assists with resource mobilisation efforts. SANBio was established alongside four other networks under the African Biosciences Initiative (ABI), for the SADC region. The ABI-network of centres of excellence was established by NEPAD across the five regions of the continent with the aim to strengthen capacities, R&I in biosciences.

• The Southern Africa innovation support programme (SAIS Phase II) contributes to the creation of inclusive business and employment through improved innovation systems and enhanced cooperation on innovation activities across five SADC-countries through the ministries responsible for STI. The programme is funded by the Finnish government with co-funding from the partner countries to the tune of EUR 8.7 million between 2017-2020. The programme established an innovation fund that uses a competitive call for proposals mechanism to identify and support local innovation and entrepreneurship projects in the SADC region. Key focus areas of the programme: (1) improving the capacity of innovation institutions and intermediaries in the region to support private sector innovation and enterprise development; (2) improving the capacity of businesses to innovate and enter new markets; and (3) improving the enabling environment for inclusive innovation in the SADC region. The SAIS 2 innovation fund provided 26 grants to pilot projects, demonstrating and replicating new or improved concepts and prototypes before rolling them out to the market as products, services or processes. Financial support went to entrepreneurship and entrepreneurial operations at local level, increasing cooperation among innovation support organisations with a practical understanding of the innovation ecosystems and activities across the SADC region. SAIS 2 set up the connected hubs networking initiative to pool individual efforts such as innovation cafes and competitions organised in different SAIS 2 partner countries under one umbrella. The objective is also to share best practices in innovation support through online and offline training sessions offered to tech hubs and start-ups together with international experts. From 2017, SAIS 2 in partnership with the SADC secretariat has organised regional and national events to host the annual Southern Africa innovation forum. The SAIS programme focuses on building capacities and providing support to early-stage entrepreneurs and related innovation ecosystems.

• The EU, under its EDF11 programme, supports the SADC region in implementing the SADC industrialisation strategy and roadmap (2015-2063) through a regional project called support towards industrialisation and the productive sectors (SIPS), with EUR 18 million in funding over 2019-2024. The SADC industrialisation strategy and roadmap aims to create innovation-driven
economies in the region by 2063 (Southern African Development Community 2015). To address the challenges of regional industrialisation, SIPS aims to: (1) facilitate better dialogue between private and public sectors; (2) improve the development and governance of key priority value chains: agro-processing with a focus on the leather value chain, and pharmaceuticals with the focus on the antiretroviral value chain; and (3) improve local manufacturing capacities. As part of the SIPS project, a competitive grants programme was designed to support regional innovation and technology development, and upgrade product development in the leather and pharmaceutical value chains. This is the first-ever regional grants programme to be implemented in the area of R&I. The total budget allocated to the programme is USD 3.6 million over 5 years. The first call was published in December 2020 with a total value of USD 1.5 million. There was a poor response and poor uptake of grants in the region. Some challenges were identified, including proposal writing and understanding of the requirements as per the guidelines. There are plans to publish the second call during 2021-2022.

3.3. RESEARCH QUESTIONS AND METHODOLOGY

Derived from the state of play the study focused on the following research questions to assess the R&I partnership between Africa and Europe:

- How aware are relevant stakeholders of the Africa-EU R&I partnership in both regions?
- How effective are the governance mechanisms of the cooperation, namely the HLPD, and how aware are relevant stakeholders?
- How aware are relevant stakeholders of funding instruments supporting the Africa-Europe R&I partnership?
- What are strengths and weaknesses of the R&I policy and governance capacities in Africa?
- How is Africa’s participation in the EU framework programme on R&I?
- How should human and institutional capacities in R&I in Africa be improved?
- How to strengthen public private/industry and academia linkages and partnerships in R&I in Africa?
- How to support start-ups in Africa in R&I?

This following section briefly outlines the research methods and data sources employed by the AG on R&I capacities in Africa to identify focus areas for coordination and strengthen the Africa-EU R&I cooperation programmes.

The collation of information began with desktop research and a literature review on the past and current state of play. A stakeholder map was developed to collate information from different representatives. A number of relevant stakeholders were identified in the areas of: governments (ministries of science, technology and innovation, including education); private sector/industry; civil society; non-governmental organisations; multilateral institutions; knowledge networks; and independent experts from Africa and Europe.

The methodology for the study consisted of quantitative and qualitative approaches.

For the quantitative approach an online survey was developed and circulated to all identified stakeholders. The first survey that was circulated consisted of 18 questions that required respondents to answer with a yes/no on questions related to knowledge about the Africa-Europe R&I partnership. The survey provided an option for those who preferred a short follow-up discussion and those who preferred to complete a more detailed survey. Follow-up consultations were set up based on the outcomes of the first survey. Overall 30 stakeholders responded to the survey; 15 males and 15 females, achieving equal gender representation.
Respondents came from seven different AU member states, three different EU member states and one respondent from the United Kingdom. With more than 60 percent the very most of respondents originate from South Africa. Close to half of respondents came from the university sector, close to a quarter from research organisations, around an eight were researchers in other organisations, the rest summed up to entrepreneurs and the public and private sector. Half of the respondents chose a follow-up consultation through a survey and to respond in writing, 40% preferred a short 5-minute online discussion, while the remaining declined a follow-up consultation (see supplementary figures 3-6 four detailed overview).

Qualitatively structured and unstructured interviews (targeted and non-targeted) were conducted with relevant stakeholders. Given the outbreak of the COVID–19 pandemic, digital platforms were used to conduct the interviews. Unstructured virtual interviews were held with seven policy makers, with a specific focus on the long-term AU-EU R&I Partnership on FNSSA, the Long-Term Joint AU-EU R&I Partnership on renewable energy (LEAP-RE), SMART specialisation and local innovation ecosystems. Information derived from the virtual stakeholder engagements of the R&I AG held between May and October 2021 was also used to inform the paper. There was also challenges experienced in scheduling online interviews with identified stakeholders due to their non-availability and also tight deadlines of the paper submission. The survey and interview guideline can be found at the end of this study.

Secondary data sources were also used for information such as reports, articles and other study documents. Case studies were used to analyse existing R&I capacity programmes and projects at national, regional and international level. The selected case studies focused mainly on existing programmes and projects in the area of R&I cooperation within the framework of the HLPD, focusing on the joint AU-EU R&I partnerships on FNSSA and CCSE as well as on the EDCTP. Case studies were also used to analyse selected bilateral and regional R&I partnerships and programmes.

The key limitation of this study was the short period of time to collect data in order to cover the wide range of partnerships in relation to African and European R&I cooperation. The study was therefore unable to do an in-depth analysis of all the programmes and initiatives being supported and implemented under the AU-EU cooperation in R&I. The low response to the survey further contributed to the limitations of the study with regard to data collection and analysis.

### 3.4. ANALYSIS AND FINDINGS

#### 3.4.1. Answers to research questions

Derived from the consultation process via interviews and surveys of selected stakeholders and the consultation of secondary literature, this section provides answers to the research questions raised in this paper.

Overall the awareness of the Africa-EU R&I partnership is limited. Through the consultation process conducted for this survey it was shown that more than six out of 10 relevant stakeholders are aware of the Africa-EU R&I partnership. However, around one fourth are unaware and one out of 10 did not answer.

With regard to the AU-EU HLPD on STI more than half of the interviewees responded that they are unaware of the forum where regular exchanges on R&I policy take place and long-term priorities to strengthen the cooperation are decided. Only 36% said they are aware of the HLPD and 2% did not answer.

The awareness of the funding instruments under the AU-EU cooperation in R&I is even lower. Only three out of 10 relevant stakeholders know of the funding opportunities under the cooperation. 2% did not answer. For the specific example of the AU research grants 60% of respondents were not able to answer on its effectiveness.
In line with these findings, 80% of respondents indicate that they have not benefitted from the EU-Africa R&I partnership, with only one 1% not answering the question.

With regard to the strengths and weaknesses of R&I policies and governance capacities in Africa a study\(^9\) shows that there is a growing need for equal partners and co-funding and the need to address the global scientific divide and strengthen the STI capacities (Kraemer-Mbula et al. 2018). STI capacity building in Africa relies on political will and government commitments to lead the process. The capacity to reform economic, social and political governance is a requirement for ensuring that STI is integrated into Africa’s development. Yet governments cannot do this on their own. They need to collaborate with the private sector, civil society organisations and academia, and build on mutual trust, accountability and effective coordination.

In the innovation and technology sector in Africa there has been an exponential growth and emergence of technology and innovation hubs and parks in Africa over the past years. Some of the key role players identified in the innovation eco-systems are innovative firms, universities and research centres, research and technology organisations and public policy institutions. These innovation activities are funded through various mechanisms and instruments such as providing dedicated funds to support innovation, training on innovation, access to knowledge and innovation sources and networks and support to intellectual property protection (Tena 2017). This has also contributed to Africa’s share of the digital economy especially in the financial services sector with platforms such as M-Pesa a Kenyan electronic mobile money service platform. Some regions such as West Africa in cities such as Abidjan, Accra, Bamako Dakar, Lagos and Ouagadougou are experiencing a rapid increase of entrepreneurial communities and networks who are reshaping the region’s technology and innovation ecosystems (Dosso et al. 2020). The model of territorial innovation policies\(^10\) has proven to be a model for good practice to support local innovation ecosystems in supporting human capital development focused on regional priorities, strengthening the relationships of the clustering of the four helix components and targeting key national or regional value chains (Tena 2017). With regard to innovation policies\(^11\) an urgent need to develop and strengthen capacities is imminent.

Support to the development and modernisation of the agricultural sector in Africa has improved through instruments such as DeSIRA. According to Guy FAURE from DG-INTPA in an interview held on (7th June 2021) there is a need to have better or improved linkages with other initiatives and programmes to improve farming systems value chains to promote added value of products, market access and improved nutrition. He also says there is a need to support incubators, entrepreneurs and start-ups in the agriculture sector. He further noted the need to improve agriculture R&I governance mechanisms to better engage farm organisations to be more involved and equal partners in the funded projects. An assessment was also conducted through a survey to analyse the role of Farm Organisation (FOs) and the gender component in the DeSIRA funded projects (DeSira 2021). The results of the survey indicate that the participation of FOs in DeSIRA projects is important even though a number of the funded projects did not take this into consideration by involving FOs as partners in the projects. The survey also indicates that the projects

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9 The study analysed six R&I cooperation programmes involving both African and EU countries: (1) the Commission framework programmes, specifically FP7 and Horizon 2020, which ended in 2020; (2) the European Cooperation in Science and Technology (COST) programme; (3) the EUREKA-Eurostars programme; (4) the ACP-EU Cooperation Programme in Science and Technology (ACP S&T); (5) the European and Developing Countries Clinical Trials Partnership (EDCTP) and (6) the African Union Research Grants (AURG) programme.

10 Territorial innovation policies are policies that foster capabilities of local actors at national, regional levels in fostering learning within innovation systems to promote development in various economic, social, environmental and cultural aspects Tena (2017).

11 Innovation policies are a result of public interventions for the generation and diffusion of innovations. These could be new or improved products, processes, marketing, organisational methods and or new collaborative modes.
provided indirect support to the FOs through services, equipment such as mobile devices and capacity building interventions.

The **funding** for research, development and innovation still remains a **key challenge** in Africa, with funding still below 1% of GDP for R&D. These challenges include weak intellectual property and technology transfer systems and weak innovation capacities to support socio-economic development. Women are also underrepresented in STEM and the lack of STI-data and access to data still remains a challenge. The continent also lacks **R&I infrastructure**. With the advent of COVID-19, Africa’s weak STI capacities were exposed. At the same time, the pandemic has highlighted the important role that STI plays in socio-economic development and sustainable health systems. A number of African member countries are committed to setting R&D priorities and formulating related science and technology policies in alignment with both regional and continental frameworks on STI. National efforts vary from one country to another. Some countries have already outlined R&D priorities in existing STI strategies or plans, while others have either recently launched national R&D priority-setting and policy formulation processes or are willing to have a baseline survey to inform the development of an evidence-based policy formulation.

**Figure 10**: Gross domestic expenditure on R&D (GERD) as percentage of GDP (African Union Commission et al. 2019)

A number of economies in Africa remain vulnerable to the volatility of commodity markets. This is largely because most of them remain undiversified, with increasingly resource-based growth and a stagnant industrial sector. In addition, the goods market in the region remains small. Research studies have shown a positive direct correlation between investments in R&D, manufacturing and economic growth (OECD 2015; Kim and Castillejos-Petalcorin 2020). This further underlines the importance of investment in R&D and innovation and in the education system. The subsequent diversification of the manufacturing sector would create the potential for expanding the goods market including intermediate goods, which provide inputs for adding value in other sectors, particularly in regional and continental value chains.

With regard to **Africa’s participation in the EU framework programmes on R&I** it can be said that more African countries participated during **FP7** (2007-2013) than in previous framework programmes on R&I, with South Africa, Egypt, Morocco, Tunisia, Kenya, Tanzania, Burkina Faso, Ghana and Uganda taking the lead on project participation. Most participants come from universities and governmental research institutions (Kraemer-Mbula et al. 2018). A contributing factor for the increased African participation was the 2010 **coordinated call for Africa**12, which prioritised African needs and priority research areas at the forefront of the funding and programme designs. The projects funded intentionally moved away from a donorship approach to a more equal partnership, combining the latest scientific discoveries with local knowledge to maximise the impact of research as well as strengthen local capacities in the relevant science.

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12 The call funded 26 projects in three thematic research areas: 15 on health, seven on environment (including climate change) and four on food, agriculture, fisheries and biotechnology.
and technology sectors and their applications through the use of training and the exchange of staff (European Commission 2009). The figure below indicates the funds invested by the EU in the African countries that participated and Africa’s participation in FP7.

![EU contribution (€ m)](image1.png)

Figure 11: Africa’s participation in FP7 (European Commission - DG RTD 2013)

The successor programme of FP7 was Horizon 2020 (H2020) (2014-2020). It was the largest EU R&I programme. H2020 included three pillars: excellent science, industrial leadership and societal challenges. The framework programme focused on acquiring additional funding by increasing the number of topics. It flagged in particular international cooperation, which saw an increase in topics from 12% to 27% from 2014 to 2017. The most active countries by projects were South Africa followed by Kenya, Tunisia, Morocco and Egypt (European Commission 2019). The figure below provides an overview of the EU’s contribution, African participation and own contribution by African member states within H2020:

![EU contribution, participation & own contribution by African member states H2020](image2.png)

Figure 12: EU contribution, participation & own contribution by African member states H2020 (European Commission – DG RTD 2021)

Within the Marie Skłodowska-Curie actions (MSCA) of the H2020 programme 1648 African researchers from over 44 African countries participated in some 149 projects. The MSCA aims to equip researchers with the necessary skills and international experience for a successful career, either in the public or the private

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Individual projects may include participants from more than one of the listed countries.
sector. The programme responded to the challenges sometimes faced by researchers, offering them attractive working conditions and the opportunity to move between academia and other settings. Participation from representatives from the African continent covered the following sectors:

![Sector representation by African member states in MSCA](image)

**Figure 13: Sector representation by African member states in MSCA (European Commission, Unit C2. Marie Skłodowska-Curie Actions 2021)**

The **human and institutional capacities in R&I in Africa** still have room for improvement. Improved capacity for research is a valuable and sustainable means of advancing any research agenda and development in Africa. Increasing the scale of science and innovation capacities is imperative for achieving a better understanding of the relative needs of countries in ensuring progressive outputs in the advancement of RDI in developing and underdeveloped countries. An imbalance in the representation of African researchers compared to European researchers exists for a number of reasons. The overarching cause is the lack of funding for research and research driven by African countries in instances where collaboration is concerned. The shortage in resources often results in repetitive results when it comes to policy execution and longevity. This is a concern where evidence-based policy implementation is key to solving socio-economic disparities, particularly for African states. There is a significant great dependency on foreign development investment in the African landscape, with considerable consequences on sustainable development.

The main approaches to improving research capacity involve providing opportunities for academic research and research training. Initiatives to provide research equipment, funding and facilitate research use for policy-making were limited, while strategies to increase research awareness, promote collaboration and provide guidance and incentives for research were lacking. Most organisations had programmes for researchers and academics, with none targeting funders or the general public. Local leadership is vital for improving research capacity in Africa. In addition to providing acceptable support to academics and researchers, initiatives that help revive the education system in Africa, promote collaboration and engage funders and the general public will assist in strengthening research capacity in Africa (Ngongalah et al. 2019).

Furthermore, an effective national system of innovation is necessary to strengthen the R&I capacities of the African continent. Studies previously conducted indicate that while admirable efforts are being made, more needs to be done to enable the African continent to seize the opportunities that currently exist. Although there are a number of regional and international institutions with programmes that focus on helping African countries advance in the area of STI, such as the AU, the New Partnership for Africa’s Development, the African Development Bank, the World Bank, the EU and UNESCO, these institutions are not well coordinated enough to add value to the building of national and regional innovation systems (Mugabe 2011).

Studies conducted on research capacity building in Africa with a specific focus on networks and institutions place considerable emphasis on the importance of integrated approaches to capacity building. They link
concerns on research training with those on improving professional practices and infrastructure in order to support research activities (The African Capacity Building Foundation 2017).

In addition, capacity building for STI policy implementation and the uptake of place-based and strategic approaches to STI-led transformation could unleash greater outcomes from the low resources available for STI activities in the sub-Saharan African region (Dosso 2017, 2019; Daniels and Dosso 2021). Further questions to be answered in this regard include whether Africa has recovered from the ‘human capital flight’ and what the incentives for increasing R&I capacities, its development and retaining are.

The state of public private/industry and academia linkages and partnerships in R&I in Africa is expandable. More needs to be done to engage the private sector from Africa and from Europe to get involved as critical actors in the R&I partnerships. It is important to note that it isn’t sufficient to increase capacities alone, but also about developing smarter and more effective means of sustaining them and ensuring that efforts and years of experience are not filtered out and crucial information is retained and passed on. Significant funds need to be invested by all states in order to function within the fourth industrial revolution. This means a large portion of private and public investment is needed, keeping in mind the human capital of science and innovation (Dosso et al. 2021).

The position of R&I start-ups in Africa is unique. In a personal interview for this study Mafini Dosso, project leader on growth and innovation at the European Commission DG JRC, stated that policy makers need to better understand sectoral structures at the country level to understand the university and industry linkages. Dosso further explained that there is a flourishing of start-ups in the continent and it is also happening in an uncoordinated way which needs to be supported with systematic capacity development efforts in ensuring a more organised and structured ecosystem is enabled. Dosso further stated local innovation systems have a potential to identify local priorities and detect new industrial opportunities for setting up systems for economic development zones (EDZs) or innovation clusters in supporting local community needs for example such in Rwanda. In the piloting of the local innovation strategies in Rwanda, the country was able to develop a SMART specialisation roadmap to unlock opportunities, policies, projects and instruments to support local innovation ecosystems.

3.4.2. Progress made on R&I policies, developments and activities in the African-European context of R&I capacities

Most African countries have regained their independence in the past few decades. During the same period, Africa has grappled with challenges to find ways to develop and apply STI in order to advance socio-economic development and growth. In the meantime, industrialised and newly emerging economies in the world have taken great strides to harness STI and therefore accelerate their economic competitiveness and economic growth, while generally improving the quality of life of their citizens in an environmentally sustainable manner. It is worth noting that African countries have now identified STI as an instrument for accelerating economic growth. Significant progress has been made in Africa with the strengthening of institutions such as the AU and the establishment of new policy organs, agencies and institutions. Policy frameworks and strategies have also been developed to advance the continent’s development and integration agenda. The dynamics of Africa-EU R&I cooperation programmes have changed and low- and middle-income economies have become more significant (Kraemer-Mbula et al. 2018).

The implementation status of the Agenda 2063 is moving forward. According to the first continental report on its implementation\(^\text{14}\), the continent has achieved good progress on aspiration 4: a peaceful and

\(^{14}\) The report was conducted following the recommendation of the ministerial meeting of the AU STC on finance, monetary affairs, economic planning and integration from 2019. AUDA-NEPAD conducted a review of the first ten-year implementation plan of agenda 2063 based on the goals, priority areas and targets to be achieved at national, regional and continental level. The report is based on progress reports from 31 of the 55 AU member states covering 56% of the continent and six regional economic communities (AUDA-NEPAD 2020).
secure Africa’, with over 48% of member states having reported the existence of functional national peace mechanisms and the establishment of a continental-level Africa peace and security architecture. Good progress has further been made on aspiration 2: an integrated continent, politically united and based on the ideals of pan-Africanism’, with a score of 44%. Little progress has been made on aspiration 1: a prosperous Africa based on inclusive growth and sustainable development’, with a score of 29%, and aspiration 5: an Africa with a strong cultural identity, common heritage, shared values and ethics’, with a score of 12%. At regional level, East Africa achieved the highest performance in 5 out of the 7 aspirations with a score of 40%. The other regional economic communities performed below 40%, with West Africa at 34%, North Africa 27%, while South and Central Africa both recorded scores of 25% against the 2019 targets. On the level of the goals, slow progress is registered towards achieving its targets in goal 4: transformed economies and job creation, goal 5: agriculture for increased productivity and production and goal 6: blue/ocean economy for accelerated economic growth. The report further notes that good progress was achieved on goal 1: well-being for all’ which among others the exponential increase in internet penetration in the continent could be one of the contributing factors. The slow progress recorded in achieving goal 5 saw low achievements on agriculture total factor productivity, despite the sector employing over 60% of the working population in the continent and it being the backbone of the continent’s source of economic income, in the form of raw materials. The continuous low returns and performance of the agricultural sector in Africa is due to many factors among them being low levels of modernisation, weak value chains and reliance on unpredictable rainfalls (AUDA-NPAD 2020).

The review of the EU funded long-term AU-EU R&I partnership for food and nutrition security and sustainable agriculture (LEAP4FNSSA) in 2020 provides a critical insight and stocktaking on the extent to which ongoing and past projects have contributed to the goals of the partnership in implementing the roadmap. From the study key policy recommendations for the future are derived. There is a need to increase the focus on the trade and markets theme as per the FNSSA roadmap as well as a need to increase focus on gender, women and young people as cross-cutting themes and for the themes to be defined as research focus areas. Furthermore, farmers’ organisations and cooperative involvement in R&I projects must be promoted better and a balanced and inclusive participation in projects both in Africa and Europe must ensure the potential role of the private sector harnessed (Agricultural Research Council (ARC) of South Africa and SLU 2021).

3.4.3. Cross-cutting issues

R&I as a driver for socio-economic development: It is important for nations to invest in STI to foster sustainable socio-economic development and growth. STI plays a critical role not only in socio-economic development and transformation, but also in the competitiveness of nations. History shows that all the countries that have industrialised and/or transitioned into knowledge-based economies have had to invest significantly in STI. R&D investment, particularly in STI, has often been correlated with changes in GDP growth. Nations that invest heavily have higher GDP growth than those that invest less. In fostering industrialisation through among others promoting STI and increasing R&D investment to levels above 2% of GDP typical of most OECD countries (Knoema n.d.), an understanding and appreciation of issues pertaining to intellectual property and related rights are of great importance in any knowledge-driven economy (Southern African Development Community 2017). Investment in STI over the years has significantly transformed a number of economies such as South Korea, which was poorer than most countries in Africa and Europe some 50 years ago.

R&I for the development in all STI disciplines: Strengthening research, innovation and technology capacities forms the foundation for development in all disciplines of STI such as health, climate and environment, space science, biotechnology, nanotechnology, and other emerging technologies. The COVID-19 pandemic has prompted some notable innovations and technologies in Africa in response to the pandemic. The continent accounted for 12.8% of the 1000 new or modified existing technologies developed
worldwide to support the COVID-19 response. Most African interventions involved digital technologies (57.8%). The use of 3D printing accounted for 25% of the inventions and robotics accounted for 11%. South Africa accounted for the largest share of domestic inventions in Africa. Some of its inventions include the development of a COVID-19 test kit and the development of 20,000 lung ventilators (van der Merwe 2021). The current COVID-19 pandemic serves as a perfect case to demonstrate that the lack of investment in research, innovation and technology capacities has exposed weak public health systems, health innovation capabilities and pharmaceutical capacities in Africa. The lack of access to personal protective equipment and vaccines has encouraged local inventions, innovations and technology development as many countries on the continent had to be self-sufficient and use local capacities and capabilities to respond to COVID-19 (UNESCO 2021).

Factors that shape the future of STI include unequal effects of the crisis on R&D across sectors, with the accelerated adoption of digital tools and techniques, and changes in the openness, inclusiveness and agility of R&I ecosystems. The crisis could also increase experimentation with new tools, policy approaches and governance models. The following recommendation can be made in this regard (OECD 2021):

- Ensuring sustained funding for R&I conducted by universities, public research institutions and firms affected by the aftermath of COVID-19 crises.
- Acting to ensure STI systems become more inclusive, and support diverse research career paths, such as support for women early career-researchers, students from disadvantaged backgrounds and introducing more flexible work arrangements allowing for childcare responsibilities.
- Strengthening support to innovative businesses affected by the crisis especially small medium enterprises/firms in order to safeguard competitive markets, through support instruments such as access to funding to sustain their operations and mitigate widening the gaps in innovation performance.
- Adopting collaborative approaches to STI policies transitioning towards more inclusive, sustainable and resilient future outlooks.

3.5. LESSONS LEARNED & POLICY RECOMMENDATIONS

The policy paper focused on investigating and mapping key policy priorities to help strengthen and improve R&I capacities between Africa and the EU at bilateral, regional and international level.

However, the results of the survey show that 63% of the interviewed relevant stakeholders are unaware of the funding instruments under the Africa-EU cooperation in R&I. This finding is further supported by the
response on the HLPD, where more than half of the respondents indicate that they are unaware of the
dialogue platform of the Africa-EU cooperation in R&I. These findings show the need to increase the
advocacy and awareness of the Africa-EU R&I partnership and its related activities. Greater visibility of the
programmes could further assist to increase the participation of Africans in EU framework programmes on
research. There is further a need to improve the representation and diversity of sectors in the Africa-EU
R&I cooperation and partnership. This is a direct reflection of their distinctive place in the African knowledge
society, as public universities produce most of the research output in Africa (50-90% depending on the
national contexts) (Maasen 2020). Africa’s public universities are strategic stakeholders for any targeted
investment in the overall African R&I capacity, notwithstanding a concurrent need also to improve the
representation and diversity of sectors in the Africa-EU R&I cooperation and partnership.

The challenges that are curbing progress in increasing R&D investment in several member states include
inadequate infrastructure, lack of R&D staff and poor capacity for translating research into commercial
outcomes. All these are highly dependent on government funding for STI. Moreover, business sector
investment in R&D is lacking in several member states. Policy steps are required to improve the
environment for higher levels of business sector R&D on the continent. Improvements in education,
infrastructure, and information and communication technologies and closer alignment between research
dependent on government funding for STI. Moreover, business sector
investment in R&D is lacking in several member states. Policy steps are required to improve the
environment for higher levels of business sector R&D on the continent. Improvements in education,
infrastructure, and information and communication technologies and closer alignment between research
agendas and socio-economic challenges are proposed as measures to improve R&D and innovation on the
continent. At a fundamental level, inadequate infrastructure, lack of R&D human resources and poor
capacity for translational research can only be overcome through a long-term approach to supporting
African R&I capacities (including in public universities), so that any Africa-EU project or programme-based
funding enhances, and is in turn supported, by long-term investments in R&I capacities (physical and digital
infrastructures, human resources and translational research).

3.5.1. Proposed recommendations

Responding to the key policy frameworks and strategies in Africa and Europe and the findings of this study,
the following recommendations are proposed to advance and strengthen R&I capacities in order to bolster
socio-economic development, growth, competitiveness and the advancement of innovation-driven
knowledge economies.

Science, technology and innovation policy, governance – Strengthen STI policy governance, science
diplomacy and advice. Support capacity building programmes on STI policy and governance to advance
national, regional and continental systems of innovation. Design programmes to strengthen the policy
capacities of science academies in Africa as independent think tanks and knowledge institutions. Improve
the collection of data on STI through capacity building programmes and by strengthening the capacities of
national statistical offices in member states. Support the existing programmes coordinated by AUDA-NEPAD
on STI indicators and strengthen the human and institutional capacities of the AU observatory on STI.

Human capital development and strengthening institutional capacities – Increase STEM capacities
at the postgraduate (Master’s and PhD) levels), mobility. Strengthen R&I management capacities across
the public university systems, research institutions. Building capacities of academicians, researchers and
scientists in open science, science communication, technology transfer and intellectual property. The
following programmes should be considered:

- Setting up programmes to support Africa intra-mobility schemes, drawing from lessons learned
from implementing programmes such as MSCA on the mobility scheme;
- Advocating inclusivity in STEM by investing in programmes that target gender, people living with
disabilities and those coming from disadvantaged backgrounds;
- Investing in programmes aimed at developing skills as part of the 4IR, while establishing key
networks with R&I management capacities at higher education institutions and research and
technology organisations;
• Training the next generation of science communicators and journalists for the purposes of disseminating research results;

• Designing capacity building programmes to strengthen research ethics in the public sector, higher education institutions, and research and technology organisations.

It is important to strengthen and build on existing programmes such as:

• African research initiative for scientific excellence (ARISE);

• Erasmus+ (international credit mobility, capacity building in higher education);

• Support mobility programmes through MSCA and establish joint Africa-EU research chairs in priority areas such as public health, Green Deal, economy and energy transitions, digital transformations for sustainable economies and societies, mainstreaming interdisciplinary and multidisciplinary social issues such as peace and security and good governance;

• Migration, mobility and overcoming discrimination.

**Innovation, technology transfer and IP** – Strengthen innovation ecosystems, technology transfer and intellectual property, informal innovation and frugal innovations including by strengthening the education capacities of universities to support this goal. Design capacity building programmes for small businesses in areas of technology transfer and intellectual property rights. Design incubation support programmes in key priority industrial value chains to boost small businesses and enterprises.

**R&I infrastructure** – Strengthen cyber-infrastructure (national research networks, supercomputing infrastructure and capacities, scientific instruments and equipment, centres of excellence, innovation and tech hubs/parks, industrial parks, regional and continental innovation clusters. Design programmes to support research infrastructure in Africa to advance innovation activities. Increase support for existing programmes such as UbuntuNet alliance for research and education networks by expanding high speed connectivity and affordable access across the education and research community. With the exponential increase in digital technologies the need for research and education networks is becoming more urgent than before. Digital transformation and emerging technologies – Advance digital and emerging technologies. The fourth industrial revolution (4IR) has the potential to help improve human development in Africa. This calls for a focus on technology applications that improve human development. There is policy pressure worldwide between open data and the goal of information protection. Achieving harmony between these two contradicting standards is a significant part of a general way to deal with information strategies. There is a need to develop measures to decrease the cost of data for disadvantaged and vulnerable groups. The growing gap should be placed as the focal point of the investigation, the question of digital divide and data costs for destitute individuals in Africa may be the most basic issue in the African reaction to the 4IR.

Drawing from the lessons learned from the 4IR framework developed through the implementation of a South Africa–EU 4IR policy dialogue, there is a strong indication that any national, regional or continental public strategy system on 4IR would require expansive and progressive commitment (SA-EU Strategic Partnership 2018) as illustrated on the next page.
Promote **open science**, **free access to scientific data and knowledge and big data**. The concept of open science is spreading rapidly across the globe. The EU has played a leading role through policies and implementation initiatives. With deep roots in the open access movement, open data policies and the development of research infrastructure, this activity has accelerated since 2013. For instance, the EU developed the European open science cloud and appointed the European open science policy platform to advise the Commission on how to develop open science policy. In April 2018, the platform published a consolidated set of development and implementation recommendations. This draws from the lessons learned from the open science framework developed through the implementation of a South Africa–EU Dialogue on open science, which identified six themes and objectives that should be considered. In this regard, it is recommended that these six recommendations should be explored for the African context when it comes to open science and big data (The SA-EU Open Science Dialogue 2018):

15 Open science is regularly portrayed as innovative work that is collaborative, transparent and reproducible and whose outputs are publicly accessible.
open data, with proposals to bring citizens closer to science and commitments facilitating the production and dissemination of scientific knowledge around the world. The policy debate and exchanges on open science is gaining momentum in Africa with organisations such as the council for the development of social science research in Africa at their conference held in Dakar, Senegal discussing opportunities and challenges to open science in the continent. As one of the outcomes from the conference the Dakar Declaration on open science in Africa was published and agreed upon. Other initiatives include the African open science platform (AOSP) initiated through a pilot programme by South Africa, through the department of science and innovation. The AOSP aims to position pan-African ambition to position African scientists at the cutting edge of data-intensive science.

**R&I funding** – Strengthen existing R&I funding instruments and schemes and establish new and flexible funding programmes at bilateral, regional and international level, while diversifying funding partners. Strengthening existing programmes such as the ARISE-programme. A number of innovative funding partnerships have also emerged over the years such as the science granting councils initiative (SGCI). The SGCI aims to strengthen the capacities of national research funding agencies or institutions to: manage research; design and monitor research programmes based on the use of robust STI indicators; support knowledge exchange with the private sector and lastly establish partnerships with other science system actors or stakeholders. The SGCI was established in 2015 through a partnership between the South African national research foundation, UK department for international development and Canada’s international development research centre. The SGCI has been supporting capacities of a number of sciences granting councils across the various regions in Eastern, Southern, Central and West Africa (National Research Foundation 2016).

**Support to existing and new innovative multi and interdisciplinary partnership platforms** – Strengthen existing partnership platforms, designing new innovative multi- and interdisciplinary partnership platforms to respond to emerging and future global challenges such as COVID-19. Deepening and strengthening the relationship between Africa and the EU continues to be a priority for both regions at a political and socio-economic level. Drawing from the lessons learned from the successful implementation of the EU bilateral programmes and agreements, which helped profile researchers on a global scale and expand R&I networks. It is recommended that the Africa-EU partnership revisit this model of expanding R&I networks while ensuring that there is policy support and alignment for activities developed within this context. There is an emergence of different R&I partnership models and frameworks at bi-regional, continental and global levels to name a few such as the technology facilitation mechanism which was established under the framework of the 2030 agenda for sustainable development. The technology facilitation mechanism is based on a multi-stakeholder collaboration between member states, civil society, the private sector, scientific community, UN entities and other stakeholders and composed of a UN inter-agency task team (IATT) on STI for the SDGs. The JRC of the European Commission is a member of IATT. It is therefore important to create linkages with existing partnerships and platforms to work towards collaborative approaches and linkages in developing R&I capacities across various disciplines. Promoting such partnerships should therefore go hand in hand with the region’s efforts to cement South-South and North-South cooperation in order to boost STI development.

**Cross-cutting areas:** Women and young people in STEM, strengthening R&I, higher education and industry linkages. There is a need to have targeted support programmes to promote women, youth and disadvantaged groups in R&I. Increasing support programmes for scholarships and mobility opportunities to build capacities and close the gender gaps and inequalities in R&I management and capabilities.

### 3.5.2. Synergies with existing policy bodies

As highlighted in the beginning, the **Joint Africa-EU Strategy** serves as the overarching framework for the cooperation between Africa and the EU, with the HLPD being the platform for formulating, coordinating and implementing joint Africa-EU cooperation activities in the field of R&I. The cooperation activities are
supported through various programmes, projects and partnerships (selection presented under 2.1.3.), and are financed through various instruments and mechanisms at bilateral, regional and international level.

The policy paper study indicates that there is a disconnect between the HLPD governance mechanism and governance mechanisms of the specialized technical committee on education, science and technology (STC-EST), which comprises all AU member states represented by the Ministries of education and STI, regional economic communities (RECs) and non-state stakeholders. Within the HLPD governance mechanisms there are also weak linkages and representation of RECs, industry and private and civil society. The following key considerations are based on the findings of the study. Some key considerations:

- Review HLPD governance mechanisms to improve linkages and synergies with STC-EST, RECs and non-state stakeholders.
- Improve awareness and advocacy on the HLPD platform at regional, continental and international level.
- Improve engagements and linkages with other similar R&I platforms, networks and institutions to leverage synergies and avoid duplication of efforts.
- Design more coordinated and active engagement with RECs, and the AU member states, this will improve regional diversification and reach in the implementation of programmes and projects supported through the HLPD platform.

Through the EU partnership mechanisms with RECs and the various EU delegation offices in Africa, dedicated programmes on STI are needed and should be linked to the newly designed partnership mechanism: the NDICI. The programming of regional cooperation priorities for 2021-2027 is currently ongoing, some being at an advanced stage. Key recommendations from the four AG policy papers should be considered to inform the programming in order to incorporate R&I capacities within regional integration programmes.

In terms of strengthening R&I capacities at bilateral level, there is sufficient evidence in studies conducted previously under the Africa-EU cooperation that points to the need to improve the coordination of different bilateral initiatives between EU countries and countries on the African continent. The implementation of Bilat programmes such the ESASTAP-project and its predecessors have been instrumental in improving the success of South Africa-EU STI cooperation. This further indicates that better coordination of various R&I initiatives could result in more optimal investment of resources through funding partners, as well as provide key resources and new tools of cooperation for both partners. A cooperative approach specifically in the agreed thematic areas will serve to better address and coordinate funding mechanisms. However, the challenge is to be more effective in addressing basic needs for sustainable development and to do so in a more informed and coordinated manner. The current Bilat programmes being implemented between EU countries and various African and international nations such as South Africa, USA, Japan, Brazil and China can be replicated with other countries using the lessons learned from current partnerships. These could also be negotiated and designed in the form of multi-country partnerships or trilateral partnerships informed by common areas of interest, geographical location and representation, with competitive and comparable advantages.

3.5.3. Roadmap

Responding to the key policy frameworks and strategies by AU and EU and the findings of this study the following roadmap/action plan is proposed to strengthen and mainstream R&I capacities in the Africa-EU cooperation partnership:
<table>
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<tr>
<th>Objective</th>
<th>Expected output/deliverable</th>
<th>Actions &amp; activities</th>
<th>Outcome</th>
<th>Impact</th>
<th>KPI</th>
<th>Responsible Actors</th>
<th>Policy alignment</th>
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<tr>
<td>Mainstreaming and strengthening R&amp;I capacities across Africa – EU partnership to advance socio-economic development and competitiveness</td>
<td>Programmes and support instruments designed to strengthen human and institutional capacities in R&amp;I.</td>
<td>Develop joint programmes to support capacities of emerging young researchers and scientists in R&amp;I management</td>
<td>Strengthened R&amp;I management capacities of emerging researchers</td>
<td>Improved R&amp;I ecosystems in African countries; reduced brain drain circulation between African countries</td>
<td>Number of programmes established strengthen human and institutional capacities; Number of people and institutions supported.</td>
<td>AUC, AUDA, NEPAD, EC, RECs, Member States, UN-Agencies</td>
<td>Agenda 2063, STISA 2024, SDGs, Africa Strategy</td>
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<td>STI policy and governance capacities strengthened</td>
<td>Programmes and support instruments designed to strengthen human and institutional capacities in R&amp;I.</td>
<td>Develop joint inter-mobility schemes to strengthen R&amp;I capacities</td>
<td>Increased networks and partnerships between Africa and Europe on R&amp;I</td>
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<td>Develop joint twinning programmes between universities in Africa and Europe in key priorities at postgraduate level</td>
<td>Increased number of post-graduate students trained</td>
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<td>Develop and implement joint Africa-Europe Centres of excellence programmes in priority areas (these could virtual)</td>
<td>Improved strategic foresight and futures management &amp; planning to adapt to changing policy environments</td>
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<td>Develop capacity building programmes and initiatives in STEM and digital skills targeting all levels of the education system</td>
<td>Improved and increased joint R&amp;I collaboration between Africa-Europe</td>
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<td>Develop and implement capacity building programmes on research ethics</td>
<td>Research ethics capacities strengthened in Africa</td>
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<td>Develop joint research chairs programmes between Africa and Europe in priority areas</td>
<td>Improved knowledge outputs and generation in key priority areas</td>
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<td>Develop and implement targeted programmes on STEM and digital skills for women, youth and disadvantaged groups</td>
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<td>Improve number of post-graduate students produced in key priority areas</td>
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<td>Improve number of emerging researchers and scientists capacitated</td>
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<td>Improve number of emerging researchers and scientists supported through mobility programmes</td>
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strenthen interactions between Africa-Europe policy makers

Develop and implement an open science framework for Africa

Establish an Open Science Advisory committee for Africa

Digital transformation and emerging technologies programmes developed and implemented

Design and implement programmes in support of the 4IR framework for Africa

Develop and implement a programme of action on 4IR and digital transformation

R&I infrastructures established and strengthened

Design and implement support instruments for R&I infrastructures investment in Africa (including support for scientific equipment)

Develop and implement framework for Increased interconnection of African & European R&I infrastructures between Africa and Europe

Develop database/portal on research infrastructures in Africa and Europe

International cooperation & partnerships established in R&I

Design and implement new innovative multi and inter disciplinary partnership platforms of R&I

Table 2: Roadmap on strengthening R&I capacities (by authors)
4. TECHNOLOGY & INNOVATION

By Bosun Tijani, Samir Abdelkrim, Dr Olubunmi Agift Ajala and Julie Lanckriet-Goerig

4.1. EXECUTIVE SUMMARY

This chapter focuses on the role of innovation and technology as contributors to economic growth, addressing 4 research questions:

1. What is driving technological innovation in Africa?
2. What is the impact of EU innovation support programmes in Africa?
3. What are the origins of the digital revolution within African societies; how can we identify best practice in developing a competitive innovation ecosystem?
4. What is the capacity of technological ecosystems and their communities to initiate collective action and structured dynamics?

To answer questions 1) and 2), the study builds on a literature review, analysis of economic statistics, and quantitative assessment of EU-funded R&I projects. To answer questions 3) and 4), interviews were carried out with 61 African stakeholders, and initiatives launched in response to Covid-19 were analysed.

The theoretical point of departure is that technology has the potential to increase productivity at country and firm level, and that technology hubs which emerged thanks to improved digital infrastructure play an important role in fostering innovation and deploying technology in local tech ecosystems and key economic sectors. The potential role of trade and knowledge exchange along with foreign direct investment (FDI) in improving economic productivity is also investigated.

The study finds that the dynamics of technological innovation vary by economic sector, reflecting the different challenges Africa faces in each. In areas such as fintech and health services African innovation is cutting-edge. Factors that shape technological innovation in Africa include: Internet access, mobile money and the role of the private and corporate sector, investors and development financial institutions, and of the African diaspora in facilitating flows of knowhow, investment and R&I back into the continent. Conversely, governments and the public sectors are largely lacking behind, or even impairing the further development of ecosystems. Universities have mostly been absent in the development of tech ecosystems and failed to adapt.

African tech ecosystems proved to be able to react to major disruptions such as the Covid-19 pandemic. New partnerships were created across Africa and with global partners, and digital innovations increasingly adopted. The Africa-Europe Innovation Partnership (AEIP) helped tech hubs from both continents to collaborate on a virtual basis. Such programmes should be continuously supported by policy-makers, helping open markets and breed innovation.

Based on these findings, a set of lessons learned can be identified and policy recommendations made for how to incorporate technology and innovation into all strands of African-European R&I collaboration:

In agriculture, collaborative research in areas such as remote sensing applications should be supported, alongside acceleration programmes for start-ups in technology areas such as Artificial Intelligence. Space and satellite technology should be transferred from Europe to Africa and talent development programmes for early-stage researchers in agritech be considered. Capacity-building programmes for public officials and harmonisation of agricultural policies under the African Continental Free Trade Agreement (AfCFTA) could help. In finance, an advisory group on virtual money should be set up. Knowledge should be shared on the role of big data and machine learning. Financial literacy and capacity-building programmes for policy makers should be considered. Payment interoperability for cross-border trade in the AfCFTA...
should be supported. In healthcare, applied collaborative research programmes should be supported. Knowledge transfer on telemedicine, smart devices and informatics could also be facilitated. Scholarships for early-stage researchers in this area could be considered.

Looking beyond specific sectors, it is recommended for African policy makers to create a dedicated legislative and financial framework for business creation. The i4Policy Foundation model for start-up acts as an inspiration in this regard. Public procurement should be opened up to start-ups and entrepreneurs, and open innovation cooperation with the corporate sector be encouraged.

EU policymakers should share their experience with their AU counterparts on how to align regulation at continental level in areas such as technology and innovation. They should support the AU in efforts to fully implement the AfCFTA, design a framework for intellectual property, data collection and data protection, improve cooperation on research and technology, and use the AU-EU high-level policy dialogue (HLPD) on science, technology and innovation to institutionalise such exchange. The creation of home-grown data centres in Africa is another area in which Europe could provide relevant insights.

The funding gap for early-stage start-ups should be addressed by supporting business angels and the creation of fund of funds and interest-free loans. The African diaspora in Europe should be engaged for the transfer of knowhow into African tech ecosystems through business development, mentorship and funding. An innovation guarantee fund could incentivise banks to finance start-ups. Tech-hubs could be supported in developing larger networks, based on the model of Impact Hub or CcHub.

Entrepreneurship and innovation should be integrated into education from primary all the way to university. A student-entrepreneur status could help, building on the AUF SALEEM programme. A vetting and training system for developers as pioneered in Kenya (Andela) could be adopted across Africa.

The priorities for the next one to three years should be to create start-up accelerator programmes, enable knowledge and technology transfer, facilitate applied research programmes, and provide grants and scholarships to early-stage researchers. Exchange programmes for companies and research institutions, co-investments in key economic sectors, funding of tech hub networks and thematic exchange programmes are areas for medium-term intervention. Policy priorities include capacity-building programmes for public officials, alignment of regulation under the AfCFTA, regulatory sandboxes, policy hackathons and digitalisation of government services. A joint AU-EU fund to support innovation in priority sectors, engagement of the African diaspora and roll-out of curricula for entrepreneurship should be set up. Initiatives such as the AEIP should be extended by further assessing entrepreneurs’ support needs and provide targeted support to successful tech hubs.

The priorities for a time horizon of three to five years include collaborative research, talent development programmes, joint advisory groups on virtual money and big data and funding for collaboration between African and European research institutions and start-ups. Furthermore, technology demonstration projects should involve stakeholders from both continents. Payment interoperability in the AfCFTA should be another priority, as are e-government strategies and policies to attract investment into local start-ups. Within the AfCFTA framework, committees should be set up involving tech ecosystem stakeholders to further develop cooperation. The HLPD should institutionalise AU-EU exchange on these topics.

4.2. STATE OF PLAY & PRIORITY TOPICS

The scientific foundation of this study lies in growth theory which has long established that improvements in technology have an effect on long-run economic growth (Romer 1990; Aghion and Howitt 1998). Moreover, differences in technology have been found to be an important determinant of differences in total factor productivity across countries (Klenow and Rodríguez-Clare 1997; Hall and Jones 1999) and across
firms (Griliches 1998; Parisi et al. 2006). The last 10 years have seen the emergence of different kinds of innovation intermediaries across Africa. These intermediaries, known as technology hubs, have been driving significant awareness, while mobilising resources to support innovation across key sectors on the continent.

The emerging technology and innovation ecosystem on the continent is now driving significant value by improving technical efficiency in critical industries.

To scale the progress, however, Africa must reinvent its approach to building innovation systems by using its extensive network and relationships to deepen support for innovators, and increase access to knowledge and expertise, to create new value.
To provide a recommendation for how to use innovation and technology to create shared prosperity between Africa and Europe, the group adopted the sectoral innovation system as a theoretical framework. This framework provided a robust opportunity for us to determine what is powering technical efficiency in five critical sectors in Africa, namely: agriculture, financial services, consumer goods, infrastructure, and health & education. The sectoral system processes change and transformation through the co-evolution of its various elements: knowledge and technology, organisations and networks, and institutions.

As a complementary approach, the group conducted an empirical qualitative analysis of African technological ecosystems, focusing on major factors and organisations that contribute to the emergence and structure of such ecosystems, through a series of stakeholder interviews (61 interviews), to understand the causes of innovation and in very distinct ecosystems, to identify best practice and make recommendations for releasing the potential of digital technology to strengthen AU-EU cooperation in this field.

The origins and emergence of tech ecosystems in Africa stem from the mobile revolution of 2008-15 (Abdelkrim 2017). African mobile penetration jumped from 375 million in 2008 to 500 million in 2010 while USD 50 billion were invested by major telecommunications companies between 2007 and 2012, creating 1.3-2.4 million direct and indirect jobs as of 2015 (Skouby 2014; Xu et al. 2018). Investing in information and communications technology (ICT) infrastructures has rapidly become the prerequisite for digital innovation to take place and be developed. The spread of these technologies throughout the continent permitted Africa’s total inbound international internet bandwidth capacity to increase more than fiftyfold in just 10 years reaching 15.1 terabytes per second (Tbps) in December 2019 - up from only 0.3 Tbps in 2009 (Africa Bandwidth Map 2021). The same process happened for the operational fibre-optic network, which increased fivefold over 10 years going from 280,000 km in 2009 to 1 million km in 2019. This investment in infrastructure definitely increases internet coverage, giving 88% of people the possibility of subscribing to mobile data services by 2018 (African Union Commission & OECD 2021).

The growth of African tech ecosystems has been sustained and structured ever since (+278% growth in funds raised by tech companies between 2015-2020, from USD 185 million to USD 701 million (Disrupt Africa 2020)).
Although this dynamic is concentrated in specific tech hubs around the continent (Nigeria, Kenya, South Africa and Egypt, also described as "the Big Four") it also thrives in less advanced countries or areas affected by crisis, such as the Sahel and Northern Africa: Morocco and Tunisia rank number six and seven in the rankings of equity rounds secured per country in 2020; Mali and Libya number 24 and 25 respectively (ibid.).

While in 2015 only 55 start-ups were funded, this number grew up to 359 in 2020, revealing a growing annual rate of 46%. This fast-growing rate can also be explained by the dynamism of African entrepreneurs themselves. According to the African Development Bank, “in 2017 alone, 22% of Africa’s working-age population started a business, which for that year was the highest entrepreneurship rate in the world” (African Development Bank et al. 2017).

Following on from the above, the project will cover the following activities.
4.3. RESEARCH QUESTIONS AND METHODOLOGY

Based on the evidence set out in the previous section, the four major research questions have been identified:

- **What is driving technological innovation in Africa?** Looks at innovations by sector, to assess the drivers of technological innovation, based on priority sectors (agriculture, health, education, finance) across Africa.

- **What is the impact of EU innovation support programmes in Africa?** Uses the triangulation method to analyse data and project information from multiple sources (including the EU’s “Cordis H2020 projects” and “Cordis H2020 organisations” dataset) to evaluate the impact of EU-funded innovation programmes in Africa.

- What are the origins of the digital revolution in African societies, and how to identify best practice in a competitive innovation ecosystem? Following the assumption that tech ecosystems and their communities support key benefits and generate domino effects for their societies, this third question will focus on tech ecosystems, their communities and their common ability of creating economic and social wealth, as well as their capacity to generate development and transformation through innovation.

- **What is the capacity of technological ecosystems and their communities to initiate collective action and structured dynamics?** Documenting the contribution of tech communities as a whole, their impact on societies and their capacity to initiate collective action and structured dynamics. To narrow the research focus, the study adopted two orientations guided by the current health situation and the specific mandate for the study: document the reaction of tech ecosystems when faced with a major crisis (COVID-19), before studying their capacity to drive AU-EU digital cooperation programmes.

The following table presents the theoretical framework and methodology for each of the four research questions guiding this paper.

<table>
<thead>
<tr>
<th>Research question</th>
<th>Theoretical framework</th>
<th>Methodology</th>
<th>Sample selection</th>
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</table>
| **1. What is driving technological innovation in Africa?** | The study will adopt the framework for sectoral systems of innovation to assess the drivers of technological innovation through 25 cases. The approach focuses on three main elements: knowledge and technological domains; organisations & networks; and institutions. | Assessment of multiple case studies of 25 top innovations from across the top five priority sectors in Africa to determine the drivers of innovation in Africa. The study will apply a mixed-method approach that combines techniques of organisational history development, inductive data analysis, and content analysis. | • Size of investment  
• Regional coverage  
• Economic contribution  
• Technical efficiency |
| **2. What is the impact of EU innovation support programmes in Africa?** | Empirical quantitative and qualitative analysis of EU-funded innovation programmes for capacity building, access to funding, technology transfer, and policy development. | This study uses the triangulation method in analysing data and project information from multiple sources to evaluate the impact of EU-funded innovation support programmes in Africa. | • Recency of projects (last 10 years)  
• Project budget size  
Project focus areas (capacity building, access to funding, technology transfer, policy development) |
| **3. What are the origins of the digital revolution in African societies, and how to identify best practice in a competitive innovation ecosystem?** | Empirical qualitative analysis of African technological ecosystems, focusing on major 61 protocol interviews through written responses or live interviews to protocol and... | This study is based on the QCA map method, a dedicated tool for analysing large quantities of... | |

16 See glossary at the end of the document on a definition of the term ‘ecosystem’.
revolution in African societies, and how to identify best practice in a competitive innovation ecosystem?

4. What is the capacity of technological ecosystems and their communities to initiate collective action and structured dynamics?

The study will adopt an initiative mapping approach, to aggregate and classify data relating to digital initiatives launched on the African continent, to respond to the direct/indirect effects of the COVID-19 pandemic. This study is based on:

1. **Geographical** – the initiative is/has been used in Africa and was created by at least one African structure/individual.
2. **Goal-oriented** – the initiative was created to fight the pandemic and its consequences (social, economic and health).
3. **Tech-based** – the initiative’s product or service is at least partially tech-based.

**Innovative aspect** – the product or service is new or has been upgraded to face the pandemic and can therefore be defined as an innovation.

Factors and organisations contributing to the emergence and structuring of such ecosystems to identify invariants and common patterns. Qualitative materials. Through a qualitative content analysis, this method follows a strictly rule-guided procedure containing qualitative steps (assignment of categories to text passages) and quantitative steps (analysis of category frequencies). We are applying this method to the research to analyse text materials coming from the interviews and protocols. Updated field interview materials from the TechAfrique project by Samir Abdelkrim in 2014–18 (20 interviews) (TechAfrique n.d.).

Table 3: Methodology research questions innovation (by authors)
4.4. **ANALYSIS AND FINDINGS**

4.4.1. **The drivers of technological innovation in Africa**

The drivers of technological innovation in Africa can be distinguished for each of the four sectors in scope of this part of the research.

In **agriculture**, Africa’s growing population and global food security present a compelling case to further contribute to GDP across the continent. At the same time, gross production index and rural-urban migration depict a sector struggling to increase value despite significant advantages.

Growing evidence of technological innovation is heralding a convergence of interests and investment with early opportunities seen in fields such as crowd farming, precision agriculture, and advisory & information services. This sees the emergence of a digital innovation ecosystem for agriculture on the continent. Organisations and networks, knowledge and technological domains, and institutions (regulations, policies, norms, etc.) are all shaping this ecosystem.

For shared prosperity between Africa and the EU, there is an urgent need to strengthen know-how and technology application, build thematic networks and relationships, co-invest in start-ups, and most importantly improve capacity for proactive policy development.

In **finance**, it is noteworthy that assets of non-bank financial institutions as a percentage of GDP in Africa have risen significantly from 11% to 21% in the last decade. This represents continuous movement compared to its level in 1960 (7%).

At the same time, Africa ranks lowest in terms of banking services coverage. At the lowest point over four decades, Europe had 30 commercial banks per 100,000 adults while Africa, at its highest point, had fewer than 10. Other continents maintained about 15-20 commercial bank branches per 100,000 adults within the same period. While African countries still perform poorly on the traditional financial inclusion index, the introduction by IFC of the Digital Financial Inclusion Index sees more African countries performing much better than countries from other regions (Khera et al. 2021).

The emerging digital innovation ecosystem on the continent is heralding a surge in financial services innovation. Technologies such as mobile money are driving rapid growth in bank account ownership. In addition, advances in payment technologies are driving the growth of e-commerce and the digital economy, while virtual currency is providing an alternative means of exchange (Xu et al. 2018).

For shared prosperity between Africa and the EU, there is an urgent need to accelerate proactive policy formulation to bridge the gap between innovation and policy. Joint efforts to support payment interoperability should be prioritised for cross-border trade under the AfCTA.

In **health services**, Africa faces a twin health crisis (fragile health systems and high burden of diseases).

With the aggregate value of average health spending on the continent in 2000-18 being USD 53.88, the world average during the same period being USD 574.15, emergency healthcare expenditure is increasingly disruptive to families and dragging some into a poverty trap.

Despite the dearth of resources, Africa is witnessing a boom in digital innovation in application areas. Among many others, these include: blockchain technology for drug counterfeiting checks; mobile phones and social network platforms for maternal healthcare and telemedicine; web and mobile apps for digital health financing; drones for the delivery of blood and medical supplies.

With investment in health-tech start-ups growing by 257.5% between 2019 and 2020, there is a noticeable disconnect between traditional organisations and the drivers of the emerging innovation ecosystem (mostly private organisations). While government participation in the ecosystem is limited, there is evidence of better outcomes when government, foundations and development agencies engage (Mureithi 2021).
To drive better outcomes from investment in health innovation by both public and private sectors, there is an urgent need to strengthen the capacity of governments across Africa to enable health-tech innovation through collaboration and proactive regulations. We must also strengthen know-how and technology application, while building thematic networks and relationships.

Finally, when it comes to education, a UNESCO report indicates that every USUSD1 spent on education can generate up to USUSD15 in economic growth and further projects that if 75% more 15-year-olds in 46 of the world’s poorest countries were to reach the lowest OECD benchmark for mathematics, economic growth could improve by 2.1% from its baseline and 104 million people could be lifted out of extreme poverty (UNESCO 2012).

A review of expenditure on education across Africa shows that though Sub-Saharan Africa spends a higher percentage of total government expenditure on education than other regions, the continent’s expenditure on education as a percentage of the GDP is the lowest of all regions.

With accelerated diffusion of the internet across the continent and the persistent drop in the price of digital devices, the education technology industry witnessed an increase of about 80 per cent (USD 7,651,100 – USD 13,720,500) in funding between 2019 (26 deals) and 2020 (28 deals). In the same trajectory, in the first 6 months of 2021, EdTech companies have raised USD12.83M in disclosed funding, which is about 90 per cent of total funding, for the previous year.

To avoid exacerbating existing inequalities, technology must be approached with care and attention. Governments and key stakeholders across Africa are partnering with technology start-ups to rally around a common goal to address the education crisis. Frameworks are emerging for promoting collaborations amongst these organisations to drive sustainable and holistic actions that maximise the outcomes of interventions across different levels of the education system.

In order to accelerate the growth of economies across Africa, investment in education must capture the opportunity technology presents to reach learners and most importantly, drive better learning outcomes. AU and EU must focus on collaborations that leverage European know-how in driving inclusive education through technology by linking academics, Edtech start-ups and investors for mutual benefit.

4.4.2. The impact of EU innovation support programmes in Africa

Of all the 35,154 Commission funded projects identified through the data collection for the period between September 1, 2005, and April 1, 2023, the top 10 active African countries participated in 141. South Africa alone participated in 26 projects (over 18%), followed by Kenya (24), Ghana (20), Uganda (14) and Ethiopia (12). The 10th most active country (Malawi) was identified as a partner in 7 projects. East Africa recorded the highest number of participating countries (5), followed by West Africa (4) and South Africa, the lone participating country from Southern Africa. Tunisia featured in the same number of projects as Malawi thus taking 11th and joining 2 other North African countries in the top 20 countries list. Anglophone countries dominated the top 10 list, with 7 slots (excluding Ethiopia), 2 slots going to francophone countries.

Figure 23: Projects by country between 9/2005-4/2023, that are African-focused – data retrieved from cordis H2020 projects (by authors)
A total of 225 participants from the top 10 participating countries were featured across all the reported projects amongst the cohort. In the analysis, we classified these organisations into 4 key categories (public institutions, research and academic institutes, associations and foundations and private sector).

The above figure shows that 46% of the participants are research institutes (including universities), followed by the private sector at 24%, public institutions at 22% and associations and foundations at 8%. Despite the low level of R&I investment by the private sector across Africa, it is reassuring to see a decent representation in the projects. This representation was particularly significant in projects focused on food security, Internet of Things and big data, digital innovation ecosystem and agriculture.

From the data gathered, 20 unique project focus areas were identified including public health, agriculture, food security, science technology and innovation, climate management, biomedical research, digital innovation ecosystem, water management, internet of things & big data and a host of others (Figure 25). The data highlighted the direction of the research relationship between EU and Africa which, on further analysis, revealed the research strength and expertise of the individual participating African countries. The 20 areas in total recorded 52 unique projects with the participation of the top 10 African countries. Nine of the 52 projects focused on public health, seven on agriculture, six on food security, four on STI. Together, the four areas accounted for half of the total unique projects amongst the top 10 participating countries in Africa.
The seventh supplementary figure (see annex) shows the spread of project focus areas by the top 10 participating countries from Africa. The East African countries on the list combined are involved in more projects focused on agriculture and food security than the other regions. Independently however, Ghana, Ethiopia, Burkina Faso and Kenya appeared in more projects focused on agriculture (4, 4, 3, 3 respectively) while for food security, Kenya, Ghana, Uganda and South Africa lead (6, 5, 5, 4 respectively). Overall, 8 of the 10 countries participated in agriculture related projects while seven participated in food security. Public health is the other active area which recorded participation from eight out of the 10 top participating countries in Africa. The East African countries on the list alone were recorded to be partners in 14 of the 21 public health projects while two West African countries appeared in four projects and South Africa in three.

While most of the other project areas recorded minimal activities (i.e., one project each in animals and livelihood, social research, STEM education, built environment, national resource management etc), internet of things and big data and digital innovation ecosystem all appeared to be gaining momentum as emerging areas of collaboration with the oldest projects starting in 2016 and 2021 respectively. This mirrors the growing trends across the continent in the emerging digital and start-up innovation ecosystem.

As seen in the figure above, the data revealed Italy as the project coordinator with the highest number of projects. Nearly a quarter (49) of all the projects with the top 10 African countries were led by Italian partners. This was followed by Netherlands at 29 projects, Germany at 27, Finland at 26 and France at 20.

The breakdown of the allocation by focus areas highlights some of the key priority areas over the last 10 years. Of all the projects involving the top 10 participating African countries, food security received the highest allocation €501,929,229.25 with only €10,927,586.47 going to the participating African countries. This was followed by agriculture at €260,327,943.70, climate management €79,133,346.39, public health €76,572,408.75, water management €52,735,335.40, internet of things and big data €40,233,296.30 and digital innovation ecosystem €35,006,220.70. The percentage of the budget allocated to African partners was quite similar across board except for public health which received a relatively higher percentage as shown in the pie charts in figure 27.
A notable pattern in the budget allocation can be seen in the breakdown of funding by the type of participating organisations (figure 28). Similar to what is obtainable in Europe, research and academic institutions received 53% of the funding to participants followed by public institutions at 23%, private sector 16% and association and foundation at 6%. The nature of the funding scheme certainly favours this pattern but the reality of how innovation happens in Africa may question the effectiveness of this pattern.

Figure 28: Allocation by participant types (by authors)

The origins of the digital revolution in African societies and best practices in a competitive innovation ecosystem

Factors & organisations identified for the emergence of African digital revolution

The emergence of the tech ecosystem and the structure of their communities around the continent seems to have arisen from a combination of specific factors and decisive, who themselves are becoming structured along the way.
In spite of the undeniable diversity of 55 countries, constantly cited by respondents, several simultaneous factors and four aggregated groups of organisations emerge as the most identified components of this continent-wide digital revolution.

The first factor is the increase in mobile penetration and internet penetration are the two major factors responsible for the emergence of the digital revolution on the African continent, regarded as a necessary combined phenomenon.

Two other factors contributed positively, though in a less decisive way, to the emergence of technological ecosystems on the continent:

1. The affordability of technological solutions (with China as a major provider)

2. Mobile money as a key component deriving from the two factors mentioned above.

These serve as a catalyst for a global tech adoption and development of digital habits around the continent (Lanckriet 2020).

Another notable factor is the scaling up of success stories in the Big Four\(^\text{17}\) again, sparking inspiration and vocations throughout the continent to launch new businesses.

As regards key organisations that play a mostly positive role in the emergence of the African digital revolution, tech hubs are the first aggregated group identified as epicentres of tech ecosystems, responsible for access to infrastructure and gathering points for the emerging communities and skill providers. A crucial function that emerged for this group, along the tech ecosystem’s structure, was that of advocacy towards public organisations.

The private sector is the second identified organisation to have played a major role in the origins and development of tech ecosystems, through financial support, connectivity and training. This group can be divided into sub-groups:

- Major corporates responsible for the specific business culture that they brought along.
- Telecom companies, for the billions of dollars of investment realised for connectivity, surpassing all other industries in this regard.
- GAFAM\(^\text{18}\) as a provider of platforms, training courses/programmes, visibility and, again, connectivity.
- Even though venture capitalists and business angels are identified as another key pillar of the ecosystems’ structure, they are still regarded as lacking in a number of countries and in specific financial segments, with a clear gap in B Series\(^\text{19}\) and early-stage funding.
- Development finance institutions can be mentioned as a rising contributor to the development of the tech ecosystem having followed a learning curve in the last 5 years to adapt to local needs – with the German development agency GIZ as the most identified actor, followed by the EU and the World Bank.
- Finally, associations can be considered as early drivers of structure for the action within tech ecosystems.

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\(^{17}\) 80% of total funding for African tech start-ups went to the top four countries in 2020, “the Big Four” (Partech Partners (2020)).

\(^{18}\) Google, Amazon, Facebook, Apple and Microsoft

\(^{19}\) Series B are fund-raising rounds happening after the “seed” and “series A” rounds, designed to take businesses to the next level, past the development stage.
Then there are key organisations who play a neutral or in some cases negative role in slowing down the digital revolution in Africa. Firstly, this concerns public authorities and policies, often considered to be lagging behind, if not as a negative factor, impairing the development of thriving tech ecosystems.

An outstanding exception is the Tunisian start-up act, which is unanimously regarded as a positive development, and a rare sign of productive cohesion between public and private organisations within the ecosystem.

In most cases, universities have not been key players in tech dynamics around the continent or in the origins of tech ecosystems. On the contrary, their failure to provide training reflected the reality of a labour market that consolidated the role of tech hubs.

Again, the Big Four are not included in this consideration, as they host strong universities that contributed to the rise of tech ecosystems in their own ecosystems.

One key actor on the side was the diaspora, which proved crucial for developing tech ecosystems, notably in the Big Four, implementing their back end or R&I back in their country or origin, and bringing a major contribution in terms of business and investment.

For examples of best practice identified for the emergence of the African digital revolution, please refer to the annex to this document.

The capacity of technological ecosystems and their communities to initiate collective action and structured dynamics

Findings from 61 interviews and the mapping of 306 “African tech initiatives against COVID”

When faced with the Covid-19 pandemic, the capacity of tech communities to initiate measures and act as resilience factors for society proved effective. Although the restrictions imposed during lockdown affected the day-to-day economy of their local environment, the pandemic had indirect positive aspects in terms of business organisation, adaptation, and creativity.

One was the emergence of new partnerships, and coordination among organisations around the world. This mobilisation mostly emerged from active individuals in tech communities without being orchestrated by public authorities.

The pandemic also gave a boost to the use of eHealth solutions and helped demonstrate the relevance of digital health systems. These were recognised as increasing accessibility to medical services and reducing inequalities and the number of areas without medical infrastructure. Since eHealth solutions rely on data and require strong and reliable data servers to protect them, alignment of data protection regulation across regions and/or the continent is sorely needed and would have the advantage of easing the global development and adoption of eHealth solutions.

The COVID-19 pandemic seems to have served as a catalyst for the creation of digital tools and the emergence of digital partnerships, powered by tech ecosystems throughout the continent.

Those at the centre of the digital response to COVID-19 were mostly local entrepreneurs, with a trend towards sharing of information and digital tools. Tech-hubs and their communities were often a driver for innovation and mobilisation around COVID-19 in their respective countries (Lanckriet and Abdelkrim n.d.).

The response seems to have largely been bottom-up, and many tech hubs acted as a catalyst for the digital response in their community, organising hackathons throughout Africa even before the actual spread of the virus on the continent.

Innovation also emerged from civil society: a strong and coordinated response, often driven by universities to build masks, respirators and hand sanitisers. Eventually, many eHealth start-ups were very quick to
react and adapt, developing dedicated parts of their applications/services for COVID-19 and turning their business model around, often engaging in a long-term shift.

In terms of the capacity of tech hubs to drive AU-EU digital cooperation programmes, the AEIP programme and more generally AU-EU cooperation built on digital and tech hubs are recognised as being beneficial for both continents.

**The major identified impact is socio-economical value,** as these programmes are seen as improving the stability of certain countries by offering new opportunities, mainly for young people. Other impacts identified from the AEIP programme are as follows:

1. Cooperation between the two continents and programmes like the AEIP help to open up markets in both directions, breed innovation and bridge the digital divide.

2. This also reveals untapped human capital and innovation that can be scaled across the whole continent.

3. A powerful network created by the programme, with opportunities to capitalise on it.

To develop successful partnerships between AU and EU structures, programme managers must ensure an existing initial interest from the partners, as well as vision-sharing among stakeholders. The programme should also ensure it is sufficiently grounded in the realities of both sides of the programme.

The programme must also ensure that the partners on each side are equipped with enough human resources to handle it, and enable the training of partners’ staff, to increase their experience and skills. Finally, they should give partners opportunities to network (as was done by the AEIP programme).

The specific positioning of tech hubs, being close to start-ups, government officials and industry representatives alike, makes them a crucial point of entry for AU-EU digital cooperation programmes. They should therefore be included and consulted from the design phase of those programmes.

AU-EU digital cooperation programmes should focus on concrete projects and be equipped with financial means dedicated to project development on the ground.

For **examples and concrete initiatives** from the mapping of 306 “African tech initiatives against Covid”, please refer to the annex of this document.

### 4.4.3. Progress on R&I policies, developments and activities in the African-European context, by focus area

Two existing examples of the impact of cooperation that we studied are the AEIP programme and the D4D Hub programme. Findings on both initiatives suggest that cooperation between AU and EU based on digital technology and innovation are beneficial overall for both continents, provided their programmes meet certain prerequisites. A common assessment for AEIP and D4DHub initiatives is that transcontinental programmes need to be sufficiently grounded, with concrete measures and objectives to be developed, and that Tech Hubs appear to be relevant stakeholders to implement these projects and disseminate their impact directly in the field, within large communities of beneficiaries.

Although the global pandemic impaired the full implementation of the programmes, tangible benefits were identified for young people and skills building, as well as for market value and income creation. The most common form of partnership engaged within AEIP and D4DHub programmes were indeed training, sharing of technical experience, exchange programmes and networking. In a broader context, wide-ranging benefits were assessed in the form of socio-economic progress and contribution to bridging the digital divide. On the other hand, the organisations implementing the programmes need more resources and staff, and their interest in taking part in the programme should be clearly stated from the start, to ease the
application process. At the same time, they should be consulted from the start, in the design-phase for such programmes.

Another striking example of cooperation policy in the African-European context is the HLPD, which has great potential to institutionalise exchanges between the AU and the EU.

4.4.4. Cross-cutting issues

This section provides an overview of the cross-cutting issues and linkages between the four topics.

Africa has been experiencing rapid digitalisation of many sectors, mostly due to the rise in mobile phone penetration, which has also led to increasing internet usage. Technology and digital innovation has significant cross cutting implications for the other sub-group’s work. The four key recommendations are relevant to all to all the four topics are:

- Industrial research chairs;
- Grants and scholarships to early stage researchers;
- Exchange programme focusing on start-ups, researchers and policy makers;
- Establish local points of contact in government, to amplify the role of R&I in start-ups.

Investing in capacity building programmes for the African scientific community appears to be a common proposition identified by both sub-topic groups of the Advisory Group on R&I for Africa-Europe Cooperation: the technology and digital innovation group and the strengthening R&I capacities in Africa group. On the other hand, more unique cross cutting recommendations were proposed by both the health systems and technology and innovation group. These include:

- Academic think-tanks;
- Thematic tech transfer;
- Co-investment in tech start-ups;
- Facilitate capacity building for public officials to strengthen innovation in public health;
- Joint AU-EU fund to invest in technology start-ups in key sectors;
- Encourage the adoption of a relevant legal framework for intellectual property, data collection and data protection at country-level.

Finally, the specific cross cutting recommendations with a focus on the green transition and technology and innovation include:

- Academic think-tanks;
- Thematic tech transfer;
- Co-investment in tech start-ups;
- Joint AU-EU fund to invest in technology start-ups in key sectors.

4.5. Lessons learned & Policy recommendations

4.5.1. Improve know-how and technology application

- ‘Industrial research chairs’: extend the application of the ‘research chairs’ programme to industry by appointing ‘industrial research chairs’ who can be hosted by ‘think tanks’ focused on Africa and
Europe especially in strategic areas e.g., cybersecurity, green economy, to promote application-oriented research; reinforce capacities of think tanks and host research chairs within think tanks.

- Create academic think tanks to research on impact and policy recommendations and develop the concept of research/fellow, focusing on fundamental research.
- Develop capacity building programmes, addressing digital literacy, and capacity development dedicated to the African scientific community and to public officials.
- Create thematic acceleration programmes focusing on start-ups building solutions to critical social and business challenges using digital technologies.
- Enable knowledge and technology transfer on space and satellite technologies, telemedicine, smart devices, big data and machine learning.
- Facilitate triple helix applied research programmes to drive impact.
- Provide grants and scholarship to early-stage researchers in health-tech, fintech, agritech and edtech.

4.5.2. Building networks and relationships

- ‘Industrial research chairs’: Extend the application of ‘research chairs’ programme to Facilitate/sponsor exchange programmes (companies and research institutions).
- Co-invest in agritech, edtech, fintech and health-tech start-ups (AU and EU).
- Provide funding for networks of and operations by accelerators and incubators.
- Create thematic exchange programmes focusing on start-ups, researchers, and policymakers.

4.5.3. Policy framework and development

- Facilitate capacity building programme for public officials on technical efficiency and the emerging role of digital innovation.
- Provide supports for aligning trade policies under AfCTA.
- Capacity building initiatives to empower policymakers to proactively develop policies and regulations.
- Facilitate capacity building programmes for public officials on effective regulation and facilitation of innovation in health.

4.5.4. Legislative/financial framework

- Create sandboxes for regulatory proposals between government, regulatory organisations and tech communities.
- Set up policy hackathons to encourage entrepreneurs to reflect and propose their own regulations.
- Reinforce e-government measures and digitisation of business registration and tax payment.
- Establish local points of contact for start-ups in government administrations, to encourage the use of R&I as a general tool for applied digital policies, such as health, finance, agriculture and peace & security.
- Introduce a fiscal alleviation/waiver for newly created businesses.
- Create sub-regional committees with representatives of tech communities to fast-track the implementation of the AFCTA.
- Encourage the adoption of relevant legal frameworks for intellectual property, data collection and data protection at country-level.
- Encourage the adoption of quotas for start-ups and small-scale entrepreneurs within public procurement, securing fast-track administrative processes.

4.5.5. **Reinforce AU-EU cooperation for R&I innovation**
- Set up a joint AU-EU fund to support innovation in sectors identified as shared AU-EU priorities, with eHealth and ed tech solutions as a start.
- Build a joint AU-EU programme to engage the African diaspora in Europe in developing tech skills and ecosystems in their countries of origin, with a focus on business development, skill-building, mentorship and funding.
- Engage a joint AU-EU assessment of the best-performing curricula in ICT/digital/engineering in Africa and Europe (looking at the contemporary needs of the labour market).

4.5.6. **Step-up AEIP-programme with joint AU-EU initiative supporting tech-hubs**
- Conduct a detailed assessment/mapping of entrepreneurs’ needs in terms of capacity and skills.
- Determine performance measures to identify the most active and effective incubators/accelerators.
- Develop country technical facilities for prototyping/testing/trying solutions equipped with experts to advise entrepreneurs on technical knowledge.
- Support the best performing hubs with training for their workforce.
- Develop strong regional pools of mentors/investors/resources for entrepreneurs, supporting the development of hub franchises.

4.5.7. **Roadmap**

<table>
<thead>
<tr>
<th>Short to medium-term projects (1-3 years)</th>
<th>Strategic long-term projects (3-5 years)</th>
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<tbody>
<tr>
<td><strong>Improving know-how and technology application</strong></td>
<td><strong>Facilitate collaborative research activities in disruptive and emerging technologies</strong></td>
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<tr>
<td>Extend the application of ‘research chairs’ to industry by appointing ‘industrial research chairs’ who can be hosted by ‘think tanks’ focused on Africa and Europe starting with strategic areas e.g., cybersecurity, green economy</td>
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<tr>
<td>Create thematic acceleration programmes focusing on start-ups building solutions to critical social and business challenges using digital technologies</td>
<td>Sponsor talent development programmes for early-stage researchers</td>
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<tr>
<td>Enable knowledge and technology transfer on space and satellite technologies, telemedicine, smart devices, big data and machine learning</td>
<td>Create a joint think tank/advisory group on virtual money/cryptocurrency</td>
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<tr>
<td>Facilitate triple-helix applied research programmes to drive impact</td>
<td>Co-invest in a centre of excellence for big data and machine learning</td>
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Provide grants and scholarship to early-stage researchers in health-tech, fintech, agritech and edtech

Create a specialised funding scheme for applied research and collaborations between African and European research institutions and tech start-ups

Develop capacity building programme, digital literacy and capacity development dedicated to the African scientific community and to public officials

<table>
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<tr>
<th><strong>Policy framework and development</strong></th>
<th><strong>Short to medium-term projects (1-3 years)</strong></th>
<th><strong>Strategic long-term projects (3-5 years)</strong></th>
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<tr>
<td>Facilitate a capacity building programme for public officials on technical efficiency and the emerging role of digital innovation</td>
<td>Assist in creating regulatory sandboxes for digital technology</td>
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<tr>
<td>Provide support for aligning trade policies under AfCFTA</td>
<td>Provide funding for think tanks and academics on policies and regulations</td>
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<td>Capacity building initiatives aimed at empowering policymakers to proactively develop policies and regulations</td>
<td>Support the acceleration of payment interoperability across Africa to enable trade under AfCFTA</td>
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<tr>
<td>Facilitate a capacity building programme for public officials on effective regulation and facilitation of innovation in health</td>
<td>Collaborate on joint innovation sandboxes to bridge the gap between innovation and policies</td>
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### Short to medium-term projects (1-3 years) | Strategic long-term projects (3-5 years)

#### Legislative/financial framework designed to implement R&I & innovation

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<th>Short to medium-term projects</th>
<th>Strategic long-term projects</th>
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<tr>
<td>Create sandboxes for regulatory proposals between governments, regulatory organisations and tech communities</td>
<td>Develop comprehensive eGovernment strategies and enable a full access to relevant public data</td>
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<tr>
<td>Set up policy hackathons to encourage entrepreneurs to reflect and propose their own regulations</td>
<td>Design policies and financial frameworks to attract local/foreign capital to invest in local start-ups</td>
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<tr>
<td>Reinforce eGovernment measures and the digitalisation of business registration and tax payment</td>
<td>Set up a regulatory framework to enable open banking and work towards continental interoperability between financial organisations (banks, fintech, payment operators etc.)</td>
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<td>Establish local points of contact for start-ups in government administrations</td>
<td>Encourage the creation of dedicated ministries for the digital economy</td>
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<td>Introduce fiscal alleviation/waiver for newly created businesses</td>
<td>Install sub-regional committees with representatives of tech communities to look into extending the AfCFTA</td>
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<tr>
<td>Install sub-regional committees with representatives of tech communities to fact-track the implementation of the AfCFTA</td>
<td>Push for the alignment of data protection regulations at national and continental levels</td>
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<tr>
<td>Encourage the adoption of relevant legal frameworks for intellectual property, data collection and data protection at country level</td>
<td>Design a global agenda for open innovation between start-ups, corporate and government to develop cooperation, training and business opportunities</td>
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<td>Encourage the adoption of quotas for start-ups and small entrepreneurs in public procurement, securing fast-track administrative processes</td>
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### Intensify AU-EU cooperation on innovation and R&I

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<tr>
<th>Short to medium-term projects</th>
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<tr>
<td>Set up a joint AU-EU fund to support innovation in sectors identified as shared AU-EU priorities, with e-health and edtech solutions as a start</td>
<td>Use the HLPD to institutionalise exchanges between AU and EU</td>
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<tr>
<td>Build a joint AU-EU programme designed to encourage the African diaspora in Europe to help develop tech skills and ecosystems in their countries of origin, with a focus on business development, training, mentorship and funding</td>
<td>Develop targeted curricula in universities (engineering/ICT curricula) and primary education, to adjust skills to the needs of tech ecosystems;</td>
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<td>Undertake a joint AU-EU assessment of best-performing ICT/digital/engineering curricula in Africa and Europe (looking at the current needs of the labour market)</td>
<td>Develop joint AU-EU university programme exchanges, to evaluate the best-performing African and European ICT/digital/engineering curricula and create a network of partnering universities to implement and sustain best practices</td>
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<td>Initiate joint AU-EU discussions on developing home-grown data centres</td>
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| **Short to medium-term projects**  
(1-3 years) | **Strategic long-term projects**  
(3-5 years) |
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<tr>
<td><strong>Extend and scale up the AEIP programme with a joint AU-EU initiative supporting tech hubs</strong></td>
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<tr>
<td>Conduct a detailed assessment/mapping of entrepreneurs’ needs in terms of capacity and skills</td>
<td>Support the best-performing hubs with training and promotion opportunities for their staff</td>
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<tr>
<td>Determine performance measures to identify the most active and best-performing incubators/accelerators</td>
<td>Develop strong regional pools of mentors/investors/resources for entrepreneurs, supporting the development of hub franchises</td>
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<tr>
<td>Develop national technical facilities for prototyping/testing/trialing solutions, equipped with experts to advise entrepreneurs on technical issues</td>
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5. THE GREEN TRANSITION IN AFRICA

By Prof Daniel Nahon and Prof Leonardus Vergütz

5.1 EXECUTIVE SUMMARY

The green transition in Africa is key for fulfilling the 2063 Agenda - ‘The Africa we want’, putting Africa on the path to inclusive growth and sustainable development. But the green transition in Africa will also have a much bigger impact, helping the world to meet the Sustainable Development Goals (SDGs) set out in the UN 2030 Agenda, an ambitious international commitment towards a sustainable development that leaves no one behind. The green transition will help address the African and European continent’s most pressing societal challenges. Water security, food security, energy security, climate change, loss of biodiversity and ecosystem services delivery have been endangered by our actions and the development model adopted so far. These challenges are global, complex and interrelated, which makes them difficult to solve.

The first critical step in solving complex problems is to identify their root (or most significant cause). According to the research findings in this study and derived from dialogue with African and European stakeholders, it can be said that the root cause of societal challenges and the main obstacle to the green transition in Africa is the lack of healthy soil. Indeed, despite national and international efforts, Africa still ranks lowest in the Global Food Security Index and suffers from an alarming rate of land and environmental degradation.

African economies and lives are heavily dependent on agriculture, especially in the lower income countries. Healthy soils provide a range of ecosystem services that can help address many of their challenges. Developing sustainable, profitable and inclusive agriculture that ensures healthy soils, is therefore central to resolving societal challenges, transforming food systems and supporting the green transition in Africa. Developing this type of agriculture will require an in-depth knowledge of how to deal with the rather contrasting edaphoclimatic conditions in Africa, especially the largest pool of old and naturally poor soils found all around sub-Saharan Africa.

Access to clean and renewable energy is also important for sustainable agriculture, which consumes more energy than industry. Sustainable agriculture must go hand-in-hand with African urbanisation, fuelling Africa’s economic growth and redesigning greener and smarter cities, generating businesses from agricultural products, solving the housing crisis, reducing greenhouse gas emissions, improving people’s health and boosting the circular economy in cities.

To develop the solution-oriented knowledge needed for Africa’s green transition, in this paper we propose several interlinking solutions. One of the most important aspects is capacity building, both in terms of people and institutions. To cover this, we will propose the 300 Programme and the Lighthouses initiative to be carried out by African and European institutions working in close partnership. With their knowledge and expertise, the Lighthouses, dispersed across the whole continent, will literally shed continuous light across Africa. This capacity-building exercise will form the foundation for further programmes, training for farmers on the technical aspects of sustainable cropping systems, and initiatives related to entrepreneurship.

For the green transition to be successful and support the sustainable development of Africa, all activities related to the AU-EU partnership on R&I must comply with the principles of good governance and high ethical standards. Good governance will ensure the overall direction, effectiveness, supervision and accountability of the partnership, while a strong sense of ethics will ensure that the science we are producing will help, not threaten, our society. Finally, to ensure a sustainable economic development
that respects people and nature, we must give fair value to our common natural goods - soil, water, forest and air.

5.2. STATE OF PLAY & PRIORITY TOPICS

Our society faces major challenges that threaten our existence, most of them related to the indiscriminate use of resources and to environmental degradation. Water security, food security, energy security, the climate, biodiversity and several other ecosystem services have been endangered by our actions and the development model adopted so far. All these issues relate to at least one UN Sustainable Development Goal and all demand action to save our future.

To leave no one behind (the Agenda 2030 commitment of the international community) and to support the green transition in Africa, economic, social and environmental development must be addressed together. For sustainable development and the much-needed green transition to be successful, two dimensions are of paramount importance in all of the AU-EU Partnership on R&I’s activities, namely good governance and high ethical standards. Abiding by these principles will ensure respect for human rights and the rule of law, that every person is able to legitimately give their opinion, effectiveness, accountability, transparency, responsiveness, and that community interests will always be more important than individuals. Ultimately, these principles will ensure the best return on investment and reduce corruption.

Climate change, which includes not only global warming but also large-scale changes in weather patterns, results mainly from the excess of greenhouse gases emitted by human activities. This is taking a major toll on the environment, especially on agricultural systems (Holleman 2020). Changing weather patterns have been exposing agricultural systems to more intense biotic and abiotic stresses. Outbreaks of pests and diseases, and more frequent periods of high temperatures and drought, have been increasingly threatening food security and leading to land degradation, especially desertification. As land warms more than water and the northern hemisphere has the biggest land mass, the northern hemisphere has been warming up more than the southern hemisphere. Climate change is therefore taking a bigger toll on the northern hemisphere. The current fires in the USA, Canada and Russia, and the flooding in Germany, Belgium and the Netherlands, for example, are signs of that.

As most of the African continent land mass is in the northern hemisphere, this is the continent’s region that is more susceptible to drought and desertification, endangering people’s lives and aggravating the vicious cycle of climate change. Africa is currently experiencing the longest periods of drought in the world, with Sahel desertification still progressing. At the same time, the fires associated with these droughts make Africa the biggest ‘black carbon’ emitter in the world. This black carbon, produced during fires, consists of carbon nanoparticles that have a greater warming effect than greenhouse gases (Gustafsson et al. 2009; Bond et al. 2013; Bonvalot et al. 2016; Bonvalot et al. 2019). In addition to the northern hemisphere, back-to-back droughts have been having a huge toll in Madagascar, with thousands of families currently on the edge of starvation. The situation is so bad that, in some regions, more than a quarter of all children are suffering from life-threatening malnutrition. This shows the very unfair nature of climate change – a region that has not really contributed to it is among the most affected and is paying a high price.

In places where water shortages are the biggest challenge to plant biomass and food production, the desalination of seawater is an important technology to be developed, optimised and implemented. It can serve to refill deep water tables and be used for irrigation purposes, not only to produce food but also to face the harsh problem of desertification. A big side effect of the desalination of seawater is the residual brine. This is usually thrown back into the sea, destroying the flora and fauna of marine shores and creating a major environmental problem. Some countries around the Sahara (e.g. Morocco and Mauritania) and Botswana have specific conditions that would allow the building, alongside arid regions, of
desalination plants to store residual brine in artificial sabkhas. Of course, these sabkhas should be monitored constantly for safety and potential impacts should be evaluated. These countries also have an abundance of solar energy – another valuable feature for desalination plants. Having places where brine can be deposited safely, along with an abundance of clean energy, makes these countries the best spot in the world for desalination plants. Capitalising on this would help to bring water to a region where it is more expensive than oil. Indeed, fresh water could be distributed throughout the Sahelian zone through a pipeline network.

Even though the world’s birth rate has already peaked, estimates show that in less than 30 years the world’s population is likely to reach almost 10 billion – 2 billion more than today. By 2050, we will have 25% more people to feed and who will be reliant on natural resources. This growth will be especially significant in Africa, which has the world’s highest fertility rate and where the population is likely to double by 2050. This will put a lot of pressure on an already stressed ecosystem for a continent ranking lowest in the Global Food Security Index and suffering an alarming rate of land and environment degradation, despite all national and international efforts. To ensure food security for its own population and to help feed the world, agricultural productivity in Africa must double in the coming decades. Agricultural intensification is therefore imperative, not only to produce more food per area (increase in productivity) but also to secure non-farmlands and restrict further deforestation and the inclusion of natural habitats for agriculture or other anthropogenic activities. The African conundrum to find ways to provide cheap and nutritious food to the fastest growing population in the world while creating incentives to increase agriculture production and sustainability is well defined by Ken Giller (Giller 2020).

Food security, water security, energy security, climate change abatement, biodiversity protection and ecosystem services have all been recognised as existential environmental challenges for the sustainable development of humanity (Bouma and McBratney 2013). These challenges are global, complex, difficult to solve, and interrelated, with one major connector: our soils (McBratney et al. 2014). Soils are not only a major store of carbon, holding more carbon in the first metre of soil than all the carbon held in the atmosphere and terrestrial vegetation combined, they are also the only way of securing supplies of food and fibre, fresh clean water, biodiversity and renewable energy sources. Soils are a finite resource (non-renewable in a human lifetime) that has been lost at an alarming rate, especially in Africa. The process of soil formation is very slow, taking up to 1000 years to form 50 mm of soil. On the other hand, the loss of soil through erosion occurs at a rate up to 100 times faster than soil formation.

Both the United Nations and the European Union have long understood and advocated the importance of securing healthy soils. The EU’s largest funding programme for R&I – Horizon Europe – was designed to help achieve the UN Sustainable Development Goals. On the mission related to soil health and food, the essential nature of soils for life on earth is clearly stated. The importance of soils for providing a range of ecosystem services, including clean water, supporting biodiversity and regulating climate, is clearly defined. It is also reflected in the mission’s title: ‘Caring for soil is caring for life’. The mission’s 2020 interim report sets a bold goal – to ensure that 75% of European soils are healthy by 2030, in order to ensure healthy food, people, nature and climate. This should put Europe on a trajectory towards sustainable land and soil management as part of a wider green transition.

As well as tackling European issues, this mission also aims to reduce by up to 40% the global footprint of the EU’s food and timber imports on land degradation. In the Communication Towards a comprehensive Strategy with Africa, presented jointly by the European Commission and the High Representative of the Union, the importance of the AU-EU partnership for green transition and energy access is included among the five envisaged partnerships. Similarly, aspirations presented in the African Union’s 2063 Agenda call for a prosperous Africa based on inclusive growth and sustainable development. Considering that a third of all soils around the world are degraded to an extent, and that Africa is home to 60% of all arable soil reserves, Africa’s inclusive growth and sustainable development is a clear precondition for
helping the world as a whole tackle major ecological and societal challenges. Ecosystems, including agricultural systems, are closed loop and complex systems, in which soils influence, or even determine, the water cycle, vegetation, biodiversity, food production, and carbon sequestration. In return, soils are also strongly influenced by these factors.

Given the alarming rate of soil degradation in Africa and the fact that agriculture is a main contributor to greenhouse gas emissions, securing African soils is crucial for the continent’s green and sustainable transition. The lack of such a framework is allowing other countries to take advantage of it, with around 100 million hectares of arable land in Africa already being monitored by other countries with a view to producing food there (land-grabbing).

Soil health and resilient and sustainable agricultural systems are at the core of Africa’s green transition. But even though Africa and Europe’s agricultural systems may end up being similarly resilient and sustainable, their conditions and solutions to get there are very different. European soils are young and not very thick, dating from less than 20 000 years ago. As they are close to the rock parental material, the chemical composition of European soils reflects the composition of the underpinning bedrock, for good (nutrients) and for bad (heavy metals). On the other hand, African soils, especially in sub-Saharan Africa, are millions of years old and among the oldest soils in the world. They are unique and very different from European soils. These soils are usually deep (up to hundreds of metres deep), acidic, naturally high in aluminium, with high phosphorus fixation capacity, and with very low natural fertility. These characteristics are the main constraints to plant biomass production in such soils. They require different management practices than the relatively younger and more fertile soils of Europe.

New research and innovation will be needed to better understand how African soils function and how they can be better managed to ensure the continent’s green transition. If aluminium toxicity is not dealt with properly, there is no response to fertilisers and carbon input to the soils is reduced as root systems will not develop well (see figure 29). In addition, Africa’s edaphoclimatic conditions make the cycles of carbon, nitrogen and water more active (faster) than in European soils. As a result, ploughing the soils will release more carbon, nitrogen and water in Africa than in Europe. Even though the debate in Europe is about reducing and limiting the use of fertilisers and recycling, this is only possible because of the characteristics of European soils, especially the high fertility and relatively shallow soil profile. In such richer soils, a common mismanagement practice is to over-apply fertilisers, causing problems such as eutrophication of water bodies due to the leaching or erosion of nutrients from the soil to the water bodies. However, in the naturally poor soils of sub-Saharan Africa, fertilisers and soil amendments are useful for producing more plant biomass (higher yield), building more sustainable cropping systems and ensuring proper human nutrition.

Figure 29: Root system development in an acidic and high aluminium soil. In the image on the left, the aluminium toxicity was corrected through liming (calcium carbonate) only on the top layer of the soil. In the image on the right, liming was applied to the whole soil profile, decreasing aluminium toxicity and allowing the root system to grow. Better root system development improves nutrients and water use efficiency and is key to increasing carbon sequestration in the soil (Photo: Dr Roberto Ferreira Novais).
Hidden hunger, also known as malnutrition, is a major health problem in Africa caused by the lack of nutrients. As nutrients are essential for the metabolism of all living organisms, it is impossible to have healthy organisms without them. The same applies to soils, which are living organisms and a repository of huge biodiversity. **In the poor soils of Africa, fertilisers must be used to ensure soil health, as nutrients are essential for the proper functioning of plant and microorganism metabolism.** Of course, although recycling and the use of organic residues would also be good for Africa, the reality is that such products and services are not easily available there. **Improving sanitation is important for the green transition in Africa** as it would generate organic residues to be used as fertilisers, in line with the circular economy concept. However, the use of such residues has its drawbacks and poses global risks. Predictions of antimicrobial resistance in domestic sewage around the world shows Africa to be the most at risk (Hendriksen et al. 2019). There is a direct correlation between antimicrobial resistance and water quality, infections, malnutrition, and life expectancy. **Antibiotic abuse and the continuous infiltration of such residues in the soil would spread antibiotic resistant genes throughout the environment and compromise antibiotic efficacy globally** (Xie et al. 2016).

**Africa’s green transition requires a specific agricultural model tailored to local conditions - one that is sustainable and resilient to climate change.** A key first step is to develop maps of land-use suitability. These should identify potential areas of urbanisation and infrastructure (i.e. buildings and roads) with a view to avoiding the most fertile and agriculturally-suitable areas. The second step is to adopt conservation practices to stop land degradation and to restore degraded soils. These should avoid the pollution of soils and waters, protect soils from sealing and erosion, build and maintain soil fertility and soil health, and improve soil biodiversity. Building more resilient agricultural systems also involves drastically reducing (and eliminating if possible) the use of pesticides. These should be replaced by a more holistic ecosystem approach, including the biological intensification of cropping systems (see figure 30). Greater soil biodiversity will improve soil health and make the cropping systems more resilient to biotic and abiotic stresses. The active use of biological control is also important for reducing the use of chemicals, with natural enemies being kept/increased in agricultural systems through integrated management practices but also actively produced and released.

In tropical conditions, soil organic matter can be used as a proxy for soil health and soil quality. It is the most important soil characteristic as, in one way or another, it connects all physical, chemical and biological soil characteristics and properties. **Increasing soil organic matter is therefore necessary for building more sustainable and resilient cropping systems in the tropics.** This is far from easy, however, as tropical soils have the world’s lowest soil organic carbon content. Due to the environmental conditions that allow microorganisms to decompose soil organic matter all year round, the decomposition rate for soil organic matter in such conditions is up to 10 times higher than in temperate conditions. **Increasing soil organic matter in the tropics would require different approaches depending on the local conditions, but measures should always include the use of no-till systems, crop rotation and diversification, cover crops, organic and mineral amendments, and fertilisers.** Such measures can maximise plant biomass production and the input of carbon into the soil, and protect soil organic matter from mineralisation.
The green transition in Africa will depend greatly on access to green and sustainable energy. To enable the sustainable development that the world needs, old and dirty energy sources must be replaced by new green technologies, including solar energy, green hydrogen, green ammonia, hydropower, biodigesters, and biofuels. In one of the International Energy Agency’s most optimistic scenarios for 2040, electricity supply in Africa is expected to grow fourfold and generation capacity to grow three-fold (to 270 GW), which would be mostly based on solar photovoltaics. As the world endeavours to clean its energy matrix, Africa must also develop green and sustainable energy solutions, avoiding as much as possible any form of energy that has a high C footprint, including its manufacturing (life-cycle assessment). In solar energy, thermal should be favoured over photovoltaic energy when possible. This will be an important part of the much-needed green revolution in Africa, as the water-food-energy nexus is central to sustainable development. Access to energy will allow farmers to pump their irrigation systems, process food and store it in refrigerated systems, it will boost local industry and the use of modern digital tools, which will ultimately help to ensure food security in Africa. Worldwide, agriculture consumes 86% of all freshwater and four times more energy than industry. However, the reality in Africa is that there is a huge need for infrastructure, not only to produce clean and renewable energy but also to distribute it. Around 60% of the world’s population not connected to electricity lives in Africa where, due to the lack of infrastructure, electricity costs are up to three times higher than in Europe.

Despite recent advances, 600 million people in Africa still have no access to electricity, with sub-Saharan Africa’s electrification rate (45% in 2018) remaining very low compared to other parts of the world. While the expansion of centralised grids in Africa is expected to provide between 40 and 60% of new population access to electricity by 2030, almost half of the population will have to rely on decentralised energy production, including solar and other renewable sources. There is therefore a need to develop smart electricity grids. However, local solutions that consider the reality of smallholder farmers in Africa’s remote areas must also be developed, including small, affordable green electricity generators that are easy to use. Mini-grids and stand-alone systems mostly based on renewables are essential for achieving universal access to electricity in Africa. This also requires a broad, long-term local R&I effort supported by the AU-EU cooperation, as part of the Lighthouses initiative (see chapter 5.5). The 2024 science, technology and innovation strategy for Africa (STISA), part of the Agenda 2063, assures that R&I in energy is critical for reaching its goals.

The systems described above are complex, involving bottom-up and top-down controls that should be understood more holistically. A multidisciplinary approach is required to put them in place and to link the
different areas of expertise - not only soil, plant and agricultural farming practices, but also chemistry, physics and others. There is no single solution! Building such sustainable and resilient agricultural systems will depend on this multidisciplinary know-how, and will involve all interested parties to come up with the best solution for each specific condition. Building such systems will result in greater food security and food quality in Africa and beyond, improving the world’s health in a variety of ways. To be able to develop the science and technology that is necessary for this transformation, the right research, innovation, technology and entrepreneurship capabilities must be put in place. This will generate a huge opportunity for green jobs and businesses and help achieve the UN 2030 Agenda.

5.3. RESEARCH QUESTIONS AND METHODOLOGY
This paper seeks to answer underlying questions on Africa’s sustainable development and key measures for its green transition. The African economy and African lives are heavily dependent on agriculture and the use (and currently the degradation) of natural resources. This paper aims to identify and advance the policies that can support Africa’s green transition. Environmental degradation, hunger, malnutrition and poverty have long been a reality in Africa. All these issues will be exacerbated as Africa’s population doubles in the coming decades. It is estimated that 55% of the world’s desertification is attributed to anthropogenic soil degradation. The people most at risk are, as usual, the most vulnerable. Back in 2003, around 1.3 billion people in tropical developing countries were already living in marginal and ecologically-fragile lands, most of them in Africa (The World Bank 2003). Population growth, environmental degradation and COVID-19 has made it worse. The fundamental requirement of this green transition is to secure healthy soils, as the key connecting factor of our societal challenges. As the UN Secretary-General António Guterres recently stressed at the opening of the 2021 UN Food Systems Summit, we urgently need to transform our food systems for the health of all and to achieve the global goals for a sustainable development – ‘Food is life, food is hope. Changing food systems is not only possible but necessary, for our planet, for people, for prosperity’.

Soils are a gigantic storage of nutrients and biodiversity, containing over 98% of the genetic diversity of terrestrial ecosystems (Fierer et al. 2007). This soil biodiversity controls carbon and other nutrients cycling in soil and plant systems. Bad farming practices after clearing tropical forests can lead to carbon dioxide losses of up to 1000 t/ha, which should be compensated by fertilisers (Arrouays et al. 1995; Lal 2009; Nahon 2012). Abuse of pesticides and monoculture cropping directly affects soil biodiversity, with a 40% loss under monoculture and an 80% loss due to pesticides. Pesticides also end up in rivers and groundwater (Cortet et al. 2007; Ågren 2010). An important part of this work is to differentiate African soils from European soils, a key step in ensuring the right science and innovation for Africa’s green transition. As soils are a major component of the global cycle of carbon and other elements, they are crucially important for fighting climate change. If Africa does not maintain control of its territory and introduce policies to ensure land rights and prevent land-grabbing, the green transition will not be successful.

The average individual threshold for adequate nutrition is 2500 kcal/day. Despite obvious progress on feeding the global population, a person still dies of hunger every 20 seconds. The COVID-19 pandemic has made the situation worse. Of the 820 million undernourished people in 2020, 80% live ruraly and 20% are marginalised in urban areas, with more than a third of them being based in Africa. We currently produce 33.500 billion calories a day, of which 88% is plant-based. Of this, only 58% is consumed by humans - the rest is wasted. Moreover, while the average European family spends around 10-15% of the family budget on food, the average African family spends around 75% (Guillou and Matheron 2011; Nahon 2012). Thus, agriculture is at the heart of the problem and increasing yields and reducing losses are very important for Africa’s green transition. Transforming food systems to deliver food security, better nutrition and healthy and affordable food for all is absolutely necessary. ‘The real solution
is not to distribute food, but to help people to produce it’ (Togolese Gilbert Houngbo, President of the International Fund for Agriculture Development).

Globally, the agricultural sector is the biggest consumer of freshwater and energy. Ensuring its sustainability is therefore fundamental for a sustainable Africa. Increased water demand, together with the effects of climate change and reduced precipitation, have put considerable pressure on groundwater. Global agricultural production uses 86% of all global fresh water, but, in Africa, this can reach 98.4% (Hoekstra and Chapagain 2009). The continuous imbalance between groundwater extraction and refilling has caused a dramatic decline in Africa’s groundwater levels (20–65 m in the past 30 years). In addition, Africa’s northern hemisphere region has been suffering from groundwater degradation due to seawater intrusion, nitrate pollution and natural salinity changes. Urbanisation is responsible for much of this, as it increases the demand for drinking water. While the population has trebled, water consumption has increased sevenfold. The fact that a lack of drinking water is responsible for 25,000 deaths a day, killing more people than wars, clearly illustrates the importance of water security. In this sense, sanitation is imperative but still a big challenge in Africa. While access to water in Europe is simply a question of purchasing it, in Africa there is a need to step back and first deal with the question of rights and access to water.

Agriculture is the deciding factor for the reserves of freshwater, especially for water tables and rivers where water is withdrawn for irrigation purposes. This problem is particularly big in Africa’s northern hemisphere, where fossil water deposits have been exhausted due to agricultural use. To give an order of magnitude, the Sahara fossil water table is more than a million square kilometres with 31 billion cubic metres of water, of which 3 billion cubic metres are drained each year from nearly 15,000 wells. This compares with just 600 million cubic metres 50 years ago. A key way to develop and boost Africa’s green transition is to introduce the notion of virtual water (Allan 1998). This concept considers the use of water in the whole value chain, up to the final product. For example, 1 kg of beef requires 16,000 litres of fresh water, 1 kg of pork requires 5,000 litres, and 1 kg of chicken requires 4,000 litres.

This idea of virtual water requires an innovative approach on how to measure the wealth of a country. A major cause of environmental degradation worldwide is the way we assess the economic health of a country, namely in terms of gross domestic product (GDP). As GDP represents only the total monetary or market value of all finished goods and services produced by a country, it does not consider environmental elements, and therefore gives a false idea of the real economy (van Kooten and Folmer 2004). A country’s economy can only flourish if its people are adequately nourished and healthy. To be able to feed its population accordingly, a country must ensure access to food, and therefore to fertile land, water, fertilisers, and energy, all at a suitable price. Everything is connected.

The reform of the social performance measurement, requested for 10 years by the World Bank (J-M Severino) and AFD (Agence Française de Développement) is necessary. GDP is a concept that dates back to the end of the Great Depression that began in 1929, after which it was necessary to raise collapsed economies. Simon Kuznets developed the GDP concept in 1934 to measure a country’s wealth creation. However, this principle does not consider the destruction of the world’s real wealth, the one that constitutes its lasting wealth: natural wealth! There was another call to change our concept of GDP during the 2012 UN Conference on sustainable development held in Rio de Janeiro, Brazil (Rio+20). This conference laid the foundation for the UN Sustainable Development Goals (UN 2030 Agenda) and the member states requested the launch of a working group on how to complement GDP in order to better inform policy decisions. Almost 90 years after the concept of GDP was developed, agriculture based on this economic model has profoundly modified the natural environment, climate, water resources, etc. It is necessary to change it and to give value to our soil, air, water, forests, and biodiversity (Nahon 2012), to protect and restore them. Reforming the GDP concept through Africa’s green transition would be highly symbolic and would play a key role in addressing climate change.
Cities are also a socio-ecosystem with inputs on one side – fuel, food, drinking water, etc. – and waste on the other. To be sustainable and to become a ‘smart city’, this system must be supported by technological advances, strike a balance between entries and exits, and pursue a circular economy with the city functioning as an autonomous and renewable system. Cities can restore biodiversity and clean air by using electrical energy based on renewable sources. Adaptation and mitigation measures should be carried out with local and regional authorities. The city must constitute a research laboratory and innovations must be tested and adapted to it. Urban sprawl should be contained. An area of arable land equivalent to five times that of Denmark (20.000.000 ha/yr) is urbanised every year around the world. In the USA, 100 m² of soil are lost to urbanisation every second, with some developing countries advancing two to four times as fast (Genske 2003). If the value per square metre of concrete is higher than a square metre of healthy soil, urbanisation will not stop! Local laws must protect the most fertile soils. At the same time, green spaces, construction and transportation must be reconsidered.

The European Green Deal and the sustainable and smart mobility strategy for the transformation of public space, transport, mobility, street code and highways – the ZEFER programme (zero-emission fleet vehicles for European roll-out), currently running in Paris, London and Brussels, aims to demonstrate the suitability of hydrogen for fleets of vehicles for intensive use. Africa, where city populations are growing by 5% a year, requires similar modes of electric transport. The dilemma is to choose the type of energy source: batteries or hydrogen fuel cells.

Urbanisation is fundamentally transforming African societies. The share of urban population in Africa has increased from 14% in 1950 to 40% today, a change that took 110 years to happen in Europe (from 15% to 40% between 1800 and 1910). The continent is urbanising at a historically high rate and is experiencing unprecedented population growth: the African urban population doubled between 1995 and 2015, reaching 472 million people. By 2050, around 56% of Africans are expected to be living in cities.

Africa’s towns and cities are engines of growth, and if properly managed, they can nurture the sustainable development of the entire continent. Indeed, the African Economic Outlook for 2016 showed that Africa’s urbanisation holds immense potential to accelerate the structural transformation that fuels its economic growth. Urban areas represent 40% of the total population, 50% of total food consumption and 60% of the food market. Urbanisation is widening the consumer base and benefiting African food producers. According to estimates by the Sahel and West Africa Club, a platform hosted by the OECD, this situation has led to a food economy worth USD 180 billion in 2010, the biggest private sector activity by far in the region. Despite this, only one third of the necessary investment in urban infrastructure needed by 2050 has been made. Such investment would be a tremendous economic opportunity for local and foreign investors alike, as it could generate millions of jobs. Strengthening agricultural productivity, industrialisation and services through the expansion of middle class and foreign investments, is a tangible way of supporting sustainable economic growth. Moreover, higher agricultural activity will lead to higher agricultural incomes, which is also likely to reduce migration to cities.

Managing urban centres in the right way will significantly help to mitigate the effects of climate change and create solutions for shortages of water and other natural resources. Improving waste collection, access to clean energy and cost-effective clean public and private transport systems will improve air quality and decrease the contamination of soils and water bodies. Therefore, the economic, social and environmental benefits of effective urbanisation cannot be underestimated. Improving connections with rural areas, and strengthening infrastructure and services within and between cities, are central to a sustainable urbanisation strategy. The proper functioning of cities also requires effective and transparent governance. National urbanisation strategies are urgently needed in Africa, and - to be sustainable - urbanisation must harness public and private sources of finance in innovative ways. A good example in Europe is the Pact of Free Cities, signed in December 2019. The goals of its signatories include sharing information on best practices in urban development, and mitigating the housing crisis and global warming.
In Africa, initiatives to set new standards for the sustainable development of cities, tackle housing issues, ensure social inclusion, improve transportation, and reduce poverty include the ‘green cities’ of Kigali, Rwanda\(^{20}\) and Benguerir, Morocco\(^{21}\).

The information presented in this policy paper comes from more than 50 years of personal experience working in Africa to address African problems, and extensive discussions with various stakeholders, institutions, and scientists experienced in African problems. Participation in high-level ministerial meetings in Africa, and extensive discussions with institutions like FAO (Food and Agriculture Organization of United Nations), RUFORUM, CGIAR, APNI, AAA Initiative and AKADEMIYA2063, brings to the table the reality and the most pressing issues faced in Africa. RUFORUM is a network of 120 African universities focused on capacity building in agriculture. CGIAR is a global research partnership aiming to ensure food security and reduce poverty. APNI, the African Plant Nutrition Institute, aims to bring food security to Africa through enhanced plant nutrition and more sustainable agricultural practices. The Adaptation of African Agriculture (AAA) initiative promotes and supports solutions and good practices in soil management, water, climate risk, capacity building and financing solutions in order to build a sustainable agriculture in Africa. AKADEMIYA2063 is an African non-profit organisation that supports evidence-based agricultural policymaking and brings technical capabilities, especially related to data and analytics, to support the 2063 Agenda and help transform national economies to boost growth and prosperity.

Discussions were held with scientists such as Amit Roy (Executive Director of the Global Phosphorus Institute), Achim Dobermann (Chief Scientist at the International Fertilizer Association), Ismahane El Ouafi (Chief Scientist at FAO), Kaushik Majumdar (APNI), Ruth Khasaya Oniang’o (Sasakawa Africa Association) and Klaus Leisinger (Global Values Alliance). Exchanges were held with African universities and research centres, such as the Soil and Savanna Agricultural Research Institutes (Ghana), Kumasi University, Cape Coast University and University of Ghana (Ghana), Agricultural Research Institute of Mozambique, and others. These discussions and exchanges gave us a good sense of the reality in Africa and its various perspectives. Regarding renewable energy issues, several consultations were held with officials from public or private institutions (Academy of Technologies, EDF, AREVA, Schlumberger, IRIS, AIE, etc.) (Science et développement durable colloquium proceedings, 2010).

In addition, we tried to assess the materials already released by the AU and/or the EU on green transition, sustainable agriculture, sustainable development, healthy soils, green energy and climate change.

### 5.4. ANALYSIS AND FINDINGS

#### 5.4.1 Main findings

Our research identified and connected the most important issues preventing the sustainable and green transition development in Africa. The great exchange and inputs received from the stakeholders present during the AU-EU R&I partnership workshops, especially the African ones, reassured our findings. Our society is facing the same existential challenges, but each region has its own specificities. In the case of Africa, given the problems raised in this work and the main challenges they will face in the near future, the biggest connector of our societal challenges lies in the development of a sustainable agriculture that will ensure income, enough and nutritious food, and healthy soils to all Africans.

\(^{20}\) [https://greencitykigali.org/](https://greencitykigali.org/)

\(^{21}\) [https://sadv.ma/sites/default/files/2020-10/OCP_Brochure%20SADV_VilleVerte_VAng_Couv3Volets_22x22cm%20V2.pdf](https://sadv.ma/sites/default/files/2020-10/OCP_Brochure%20SADV_VilleVerte_VAng_Couv3Volets_22x22cm%20V2.pdf)
Securing healthy soils in Africa is the underpinning factor that will allow Africa to achieve Water Security, Food Security, Energy Security, Climate Change abatement, Improve Biodiversity, and sustain essential Ecosystem Services. The development of this sustainable and profitable agriculture will have a great impact on Africa’s urbanization. It will decrease the rural exodus, making it attractive to the youth, which will in turn decrease the housing crisis and the crowded cities, leading to less environmental impact, better transportation and the better overall functioning of the cities. As a main destination for non-contaminated urban residues, this sustainable agriculture will improve the circular economy of the cities, on top of feeding them with better local products, improving cities’ self-sufficiency.

As agriculture \( (\text{Sensu Lato}) \) is a major consumer of energy worldwide, small green energy solutions designed for the reality of the smallholder farmers will need to be developed to ensure the water-food-energy nexus. But a main driver for the development of such sustainable agriculture in Africa and to secure African soils is to give value to our natural common goods. While soil, air, water, land, biodiversity and all other natural common goods have no economic value they will never be taken into real consideration and protected. It is human nature to take natural goods for granted, and to only give any value to it when they are already gone. Thus, changing the way the wealth of a country is calculated (GDP) and including on it the price for the natural goods will be a main driver for the green transition in Africa and a huge example to the world.

In the end, to push for the green transition in Africa there is a huge need for knowledge to be generated in Africa by Africans to solve Africa’s issues. In order to do so, the most important aspect is to provide the right tools to allow Africans to tackle Africa’s problems, which will come from a strong development in terms of personal and institutional capacity building. Providing enough support to develop African Lighthouses and the actors that will support the development of such centres of excellence will allow them to define their most important issues and to come up with the most suitable solutions, allowing Africa, and especially its youth, to take its destiny in its own hands.

5.5.2. Brief assessment of the progress made on R&I policies, developments and activities in the African-European context of green transition

One example of ongoing African-European collaboration is the Mohammed VI Polytechnic University – UM6P. This recently-established university in Morocco is an example of fruitful collaboration between Africa and Europe, especially on issues related to Africa’s green transition. UM6P already has projects under way with academic and other bodies in the EU, such as Wageningen University (Netherlands), Aix-Marseille University (France), INRAe (France), CEREGE (France), and IPK (Germany); as well as with other European bodies such as Rothamsted Research (UK), Cranfield University (UK), and EPFL (Switzerland).

UM6P has been developing large capacity-building programmes in Africa, including the ‘Excellence in Africa’ programme in partnership with EPFL (École Polytechnique Fédérale de Lausanne – Switzerland), and RUFORUM, a network of 120 universities in 38 African countries whose mandate is to strengthen the quality and relevance of postgraduate training and research, especially in agriculture, science and technology. \textbf{The main purpose of these initiatives is to support excellence among the young generation in Africa through training and networking.} On agriculture and food systems in particular, the 14 UM6P experimental farms that are planned to be set up all around Africa are another great tool. The programmes will help bridge the gap between the science and innovation being developed in universities/research centres and the farmers, especially smallholder farmers. These technologies should be adapted and carefully matched with farmers’ real needs in order to be adopted and bring the transformation we want to see in Africa.

\textbf{On education, UM6P follows a ‘learning by doing’ approach, with a strong belief that transformation in Africa will come through innovation and entrepreneurship.} In this sense, all the laboratories, farms - even an operational mine - and the Green City of Benguerir are open to the UM6P
community (students, researchers, partners and entrepreneurs) in the form of living labs where community members can explore and test their ideas in the real world. Similarly, the most powerful supercomputer in Africa (Toubkal)\(^2\) provides major support for several initiatives, including the refinement of climatic models, opening doors to smart financing options and the use of the right management practices that would strengthen food systems in Africa. Lastly, the Green Energy Park\(^3\) is a research and innovation platform that seeks to harness the widely available solar energy, among other green energy solutions. All these initiatives position UM6P as an important partner for strengthening food systems in Africa and make it a perfect entry point for the European Green Deal and Africa’s green transition.

### 5.5.3. Cross-cutting issues

Among the four advisory groups, the first match with the green transition is the one on health systems. As soils are the foundation of nutrition and human health, securing and ensuring healthy soils in Africa will allow us to produce safe and nutritious food, fighting not only hunger but also malnutrition (hidden hunger). These problems affect millions of people in the world (many of them in Africa) and are an important part of the vicious circle of poverty and environmental degradation. Malnourished children are more susceptible to all sorts of diseases and have an overall lower body development, including brain and cognitive ability. Once they grow up, this lower cognitive ability can result in poor life decisions that keep their children in a similar situation, feeding the vicious circle of poverty and environmental degradation. Zero hunger and malnutrition are directly related to SDGs 2 and 3, but there are several other health-related SDGs that are addressed by securing our soils and by the overall green transition.

A series of emerging diseases, including COVID-19, could be better addressed or mitigated with healthier soils, which lead to healthier people and healthier ecosystems. Higher soil biodiversity builds more resilient ecosystems, helping to fight emerging fungus, bacteria and viruses. Securing our soils will also reduce or eliminate chemical and biological pollution, avoiding problems with antimicrobial resistance and human exposure to hazardous material, for example. Ultimately, healthy people are more resilient to all diseases. In addition, recent research in France has shown that evaluating wastewater and urban sewage is a good way of tracking COVID-19 across cities and this having a clearer, better-defined and optimised region of action. This should work the same way for other viral and bacterial diseases. Developing the capability to evaluate wastewater and urban sewage for such diseases would allow Africa to better control the spread of any disease, keeping its population healthier and avoiding the collapse of health systems.

To have the science and knowledge necessary to support Africa’s green transition, the right R&I capacities need to be in place. **The European concept of living labs & lighthouses is very important for Africa to develop the knowledge needed to solve African problems and to speed up the continent’s green transition.** Large computing capacities will be needed to build and improve climatic models and to work on smart financing technologies based on blockchain technology, for example. Green energy parks should be created and supported so that they generate the right technology for the different environments and realities across Africa. Desalination plants and smart irrigation systems must be developed to ensure food security and improve soil health. Digital and technical innovation hubs are also needed to unleash Africa’s full potential. Africa’s green transition will rely on a major innovation & technology revolution. Drones and digital tools, exploitation of aquifers, refined climatic models, green start-ups, gender equality, and the capitalisation of knowledge will all be very important for the green transition.

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\(^2\) [http://ascc.um6p.ma](http://ascc.um6p.ma)

\(^3\) [https://www.greenenergypark.ma](https://www.greenenergypark.ma)
Lastly, a change in vision on the economics of food systems is urgently needed to enable Africa’s green transition. **To have fairer, resilient and nutritious food systems, we must understand the true cost of the food we consume** (The Rockefeller Foundation 2021). This is aligned with innovating the way we measure GDP, by including the true environmental and social cost of all goods and services produced by a country. Currently, the price we pay for our food includes production, processing, distribution and retail, but not hidden costs like water, exhaustion of soils, environmental services, human health, and other services included in our food systems. Not accounting for them gives the wrong message to stakeholders and decision-makers and does not allow us to ensure a prosperous, equitable, inclusive and sustainable food supply chain. For example, by considering the impacts of food-related costs on our healthcare system, we could more easily diversify our diets, encourage the production of more nutritious food, and include alternative crops in our diets.

Putting a price on the water used to produce our food would also enable customers to choose food systems that use less water or use it in a wiser way. The same idea applies to more environmentally-friendly food systems; once this service is valued and included in the true cost of our food, it is easier for the end-customer to choose the most sustainable product. This goes a long way to ensuring adequate, safe and decent living conditions for food workers and producers, who often come from marginalised communities and are often the weaker players in the food system as they bear the burden of most of these hidden costs. Improving their lives would help to reduce the rural exodus and the urbanisation pressure in Africa, which is aligned with the EU farm to fork strategy. Finally, bringing the true cost of our food would also allow governments to wisely allocate money and get the best returns on it from food systems. As big buyers of food, governments have a huge power in pushing for these changes to happen. **Accounting for the true cost of food is one of the most important actions in Africa’s green transition, enabling it to build nature-positive and sustainable food systems.**

### 5.5. LESSONS LEARNED & POLICY RECOMMENDATIONS

#### 5.6.1. Making progress on AU-EU political priorities via R&I

The key conclusions from our research is that the green transition in Africa is a specific, complex and multi-faceted problem that should be faced as such. Separating it as simple single problems that would require simple single solutions is doomed to fail. The same way, while EU support is very important, the specificity of the African issues will require that the solutions for the green transition in Africa should be defined and developed by Africans. Allowing Africans to take control of their destiny is key for the success of the much-needed green transition in Africa. The recommendations below have been made with this in mind, aiming to support the development of Africa’s capabilities to respond to its own needs.

- **Knowledge demands / future R&I priorities**
  Given the different situations faced by Africa and the EU, there is a need to understand local issues in Africa to develop the needed science. This is where the 300 Programme comes in – this programme will make use of European expertise and experience to respond to the demands of African institutions and to the main day-to-day challenges they face. The 300 Programme, together with the living labs & lighthouses initiatives, should lay the foundation for the science and innovation needed to resolve local challenges.

  It is also important that all technology and innovation developed for Africa’s green transition takes a bottom-up. For agricultural innovations, farmers and practitioners should be included as co-developers in order to assure adoption of the technologies. Technologies developed with a top-down approach will not be readily accepted and are therefore doomed to fail.

- **Legal framework / ethics and regulatory environment**
  With all the investments already under way and those still to come, there is a compelling need to optimise the way in which they work together. Such an exercise would help the European Commission to increase
the impact of its investments and to make sure that they comply with ethical and environmental rules. Developing a regulation that ensures land rights and the respect of preservation areas will help Africa to design the right policies for its green transition. There is also a need to develop a carbon credit market adapted to African conditions. This will be extremely challenging, given the very heterogeneous conditions in Africa and the conditions faced by smallholder farmers. However, ensuring the pricing and monetising of carbon sequestered in natural and agricultural systems and of all environmental services that African farmers will provide is very important. It will serve as an incentive for farmers to adopt more technology and be a big push to break the cycle of poverty in Africa, which is intrinsically related to Africa’s green transition. No population can take care of the environment if it is not able to take care of itself first.

The long-term nature of the AU-EU R&I partnership will generate a lot of useful data. However, a FAIR (findable, accessible, interoperable and reusable) data management policy is mandatory for the information generated to be long-lasting. A consensus at the highest level for data standards, storage, sharing and processing, will bring common public good and synergy among multiple projects and programmes. Supercomputing facilities will play an important role as the repository of such data and their analysis for knowledge product development. The importance of data management for sustainable development is clearly illustrated in the 2021 World Bank report ‘Data for Better Lives’.

- **Bridging R&I and policymaking mechanisms**
  Initiatives including RUFORUM, AKADEMIYA2063, IFPRI (International Food Policy Research Institute), APRA (Agricultural Policy Research in Africa), and AAA (Adaptation of African Agriculture Initiative) should help provide local governments with a natural and integrated means of communication so that they are aware of the most recent innovation developments. But besides being aware and translating innovation into policies, extension programmes, financing mechanisms and incentives are also needed to enable the adoption of new technologies. Similarly, the Task Force Rural Africa (TFRA) and the Africa-Europe Rural Transformation Action Agenda provide information, projects, tools and platforms that can significantly help to integrate R&I into policies and effectively support Africa’s green transition.

- **Infrastructure**
  In addition to the living labs & lighthouses initiative, there is a need for investment in transport infrastructure (land, water and air), electric grids, green energy generators, water desalination plants and pipelines. The logistics necessary for farmers to establish sustainable agriculture and for them to be able to sell their products for a low price is essential. An alternative solution already being tested elsewhere, and which could help Africa, is a new generation of drones. These can carry heavy loads and could be put in place quickly to fill urgent infrastructure gaps. In this sense, the private sector is an important factor in Africa’s green transition and should be brought on board. This includes not only big international companies but also (and especially) small and medium enterprises, aligned with the new African Continental Free Trade Area (AfCFTA). The AfCFTA is expected to boost intra-African trade, promote industrialisation, create jobs, and improve competitiveness of African industries on the global stage.

  Turning to the lighthouse’s initiative, these should build on the successful media labs and have the scientists involved in the labs show and promote their ideas to stakeholders. Lighthouses have proven to be a great tool for connecting scientists and stakeholders, but they should go further and bridge scientific knowledge generated by scientists with that generated by farmers, especially smallholder farmers in Africa. To this end, major extension programmes and demonstration fairs should be organised each year. This is not only to bring scientists (and knowledge) to the table, but also to bring the farmers’ reality to research institutes, and to involve PhD students with the farmers themselves so that they understand their needs throughout the whole process.

- **(AU-EU) Stakeholder cooperation**
  As already mentioned, a legal framework to align, organize and optimize investments and stakeholders will help to make the most of all investments coming to Africa. The output of such a framework would be a
historical mapping of all investments coming to Africa, its impacts and possible connections with other projects/institutions, helping to ensure transparency and improve synergies. In addition, a major effort is needed to encourage African politicians to become part of the green transition and to collaborate with everyone involved, since these politicians will be among the most important players. A framework that will fully involve and inform politicians throughout the whole process is very important for taking intercountry decisions and actions, aspects that fall under the good governance umbrella.

5.6.2. Synergies with existing policy bodies
All the activities developed and supported by the Horizon Europe programme; UN Global Soil Partnership; UN World Food Programme; UN Food Systems Summit; UN Environment Programme; International Food Policy Research Institute (IFPRI); Global Soil Biodiversity Initiative; Land Use and Coverage Area frame Survey (LUCAS); International Atomic Energy Agency (IAEA); Alexander von Humboldt Foundation; iSDAsoil Africa; and OECD (Land-Water-Energy Nexus - Biophysical and Economic Consequences) are linked to the aspects raised in this paper. In addition, the following declarations, task forces, projects, communications, strategies, centres, platforms, agendas, partnerships and overall initiatives deal with key aspects of Africa’s green transition and should be taken into consideration when addressing specific points.

- Abuja Declaration on Fertilizer for an African Green Revolution
- Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods
- Task Force Rural Africa (TFRA)
- Outcomes of the Public Consultation on the TFRA (REPORT)
- An Africa-Europe Agenda for rural Transformation (REPORT)
- The Africa-EU Strategic Partnership - A Joint Africa-EU Strategy
- Science, Technology and Innovation Strategy for Africa (STISA-2024)
- Knowledge Centre for Global Food and Nutrition Security
- African Union - European Union Summit Declaration 2017
- 3rd African Union - European Union Agriculture Ministerial Conference
- 4th African Union - European Union Agriculture Ministerial Conference (Conclusions)

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25 https://www.resakss.org/sites/default/files/Malabo%20Declaration%20on%20Agriculture_2014_11%2026-.pdf
- Africa-Europe Rural Transformation Action Agenda
- The Pan-African Geographical Indications (GIs) Information Hub
- AU-EU Agrifood Platform: reinforcing the link between the EU and African private sectors
- Development Smart Innovation through Research in Agriculture (DeSIRA)
- Partnership on Food and Nutrition Security and Sustainable Agriculture (FNSSA)
- Pan-African Network for economic Analysis of Policies (PANAP)
- Global Monitoring for Environment and Security (GMES) & Africa
- Group on Earth Observations (GEO) initiatives for climate impact monitoring with Africa
- Partnership on Climate Change and Sustainable Energy (CCSE)
- Long-term Europe Africa Partnership on Renewable Energy (LEAP-RE)
- Co-production of Climate Services for East Africa (CONFER)
- DOWN2EARTH: Translation of climate information into multilevel decision support for social adaptation, policy development, and resilience to water scarcity in the Horn of Africa Drylands
- Full-value chain optimised climate user-centric services for Southern Africa: FOCUS-Africa project
- Food Systems Summit Compendium (2021)
- Sustainable Food Systems Programme - One Planet Network (10YFP)
- Environmental Rights and Governance

47. https://www.leap-re.eu/
49. https://cordis.europa.eu/project/id/869550
50. https://cordis.europa.eu/project/id/869575
52. https://www.oneplanetnetwork.org/sustainable-food-system
5.6.3. Roadmap

In this section we focus on multiple actions and envisioned implementation in time. This is summarised in figure 31 on page 128.

The AU-EU partnership is no longer in research & development mode, but rather in research & innovation mode. The scientific knowledge needed to boost Africa’s green transition must be developed in Africa, by African scientists and researchers, in local institutions and through collaborative research with European universities. We therefore propose to set up the ‘300 programme’, a 10-year programme that will support 300 PhD and postdoctoral students under an AU-EU partnership. Under the programme, PhD students will receive dual degree diplomas from their home institution in Africa and the host institution in Europe, and will spend half of their PhD in the host institution. Their subject of study must relate to real problems concerning Africa’s green transition and how to tackle them, and the host institution should be identified at the outset. The 300 Programme should cover the costs of the research as well as an allocation for the alumni when they complete the PhD, to ensure a long-lasting impact. In the first 5 years, around 30% of these scholarships should be for PhD students only. The remaining scholarships will be used to hire graduated PhDs (post-doctorates) based on merit, so that they can continue their work and hire more PhDs. Importantly, this programme will bring young people (ensuring gender equality) to the core of Africa’s green transition, empowering them to be primary actors in this transformation. Once they finish their PhDs/post-doctorates, these individuals will have to find support for continuing their work within the green transition framework. They should be able to find it through, or in partnership with, the lighthouses proposed below.

In addition to the 300 Programme, to support Africa’s green transition, key institutions will be selected as lighthouses across Africa, building on already existing centres of excellence. They will follow the European living labs & lighthouses concept, which is especially aligned with the Horizon Europe programme’s fifth mission – ‘soil health and food’. These lighthouses should focus on green transition issues and include green energy parks. A common problem with big projects in Africa is the lack of continuity. It is very important to avoid having heavy investments, used to set up research facilities, just to disappear over time due to the lack of continuous and sustainable support in the long term. There should be 10 lighthouses across Africa - chosen based on existing infrastructures, investments already in place, cutting-edge research, network and capabilities - to act as centres of excellence to guide scientific development and innovation in Africa. These lighthouses should benefit from long-term funding and scientific support from EU institutions to ensure the continuity of knowledge generation and innovation in Africa. The first five institutions will be located in Africa’s northern hemisphere region, which is the most endangered part of the continent. The first five lighthouses in the first 5 years will be:

- Mohammed VI Polytechnic University (UM6P) – Morocco
- University Cheikh Anta Diop (UCAD) – Senegal
- University of Cape Coast (UCC) – Ghana
- University of Jos (UniJos) – Nigeria
- Addis Ababa University (AAU) – Ethiopia.

The initiative will then be extended to five other institutions/countries to ensure a better geographical spread across Africa:

- Université Marien Ngouabi (UMNG) – Republic of Congo
- Universidade Agostinho Neto (UAN) – Angola
- University of Cape Town (UCT) – South Africa
The skills and expertise generated by the 300 Programme and the considerable scientific support and innovation provided by the lighthouses should also bring an innovative type of entrepreneurship, focused on green solutions for Africa (Silicon Valley of the Green), with a focus on young people and women, in strong collaboration with RUFORUM (consortium of over 120 African universities). Start-up hubs should be supported in the lighthouses, connected to a network of hubs throughout Africa and copied by other institutions. To ensure the green transition, the right R&I capacities and technology & innovation must be created/developed/supported. The green transition will create green jobs and start-ups (e.g. development of green energy solutions for smallholder farmers), making Africa a hub of sustainable technology and innovation. The circular economy is also at the core of Africa’s green transition, ensuring its sustainable development.

With all the investments already under way and those still to come, a framework is urgently needed to optimise investments in Africa, to improve cooperation and to ensure good governance. Even during our discussions with the European Commission, it was clear that the various stakeholders are not aware of all the investments currently in place. If we think about all the other individual countries and international institutions allocating funds for the development of Africa, it is impossible to organise and optimise these investments at present. The EU should gather all of its investments in one place and open this framework to all other donors. This will help organise and align worldwide investments into Africa’s green transition so that they work together to ensure sustainable investments and governance in the long term.

By securing our soils, we will improve health systems by complying with health-related Sustainable Development Goals, building ecosystems that are resilient against emerging diseases and climate change, ensuring food security and food quality, improving carbon sequestration and fighting climate change, and avoiding chemical and biological pollution. The aim is by 2030 to reduce by 60% the footprint on land degradation in Africa, mitigating soil degradation, deforestation and loss of biodiversity.

To achieve this, we need multidisciplinary and integrative research and to create soil, water and air observatories to evaluate and ensure environmental quality. Various companies and institutions are already generating such information, but collaborative working arrangements are needed to gather this information and to guide how it should be generated (e.g. Global Soil Partnership). The creation of such observatories should be supported by using satellite information, drones and other state-of-the-art digital technology to monitor the vast lands of Africa (e.g. GMES & Africa).

Once these observatories are launched and we have more knowledge on the condition of African soils, farmers must have access to irrigation systems, seeds, fertilisers, amendments and good support from agricultural extension agents. This will help ensure that they are using all the available technology to improve the economic and environmental sustainability of their cropping systems. The most comprehensive and essential concept to ensure healthy soils in Africa will be the soil security framework. This relatively new concept has been developed and advocated by European scientists and presents soils as the main connector of our major societal challenges. This concept is totally aligned with the land-water-energy nexus. Its greatest advantage is that it brings together various dimensions, including soft dimensions such as the cultural and economic values of soils, with a view to ensuring healthy soils. This concept needs to be further developed and implemented in partnership with European scientists under the 300 Programme.

The information generated by these observatories, together with already existing data (iSDAsoil, Soil Grids, etc.), should be used to enforce land rights and establish the required native vegetation preservation areas in Africa. Land rights must take into consideration cultural aspects and gender. Even though women account for most smallholder farmers and agricultural workers in Africa, they have less power over their land. Land rights would also be an important mechanism to ensure foreign countries and companies respect and
comply with Africa’s green transition. Without this, the door will be open to land-grabbing and to the sense that stricter environmental rules could be overruled without major consequences, leading to environmental degradation. Empowering people and governments are key for combating such problems. Ensuring land rights is also the first step towards implementing any measures to ensure healthy soils, including native vegetation preservation areas. These areas should be present within each farm (or specific region) to make sure that native vegetation will be maintained in enough quantity in the various ecological zones across Africa. These preservation areas should also be established in a way that would allow the preserved areas to be connected, thereby forming ecological corridors that would allow animals to move (migrate) and explore the whole continent.

However, to preserve these native vegetation areas and other environmental services, farmers should receive payments or incentives. In this sense, developing certification methods to ensure nature-positive solutions, providing economic incentives and establishing a carbon credit market in Africa are all essential for Africa’s green transition. Creating this market would allow farmers to receive payments for the ecosystem services that they have been providing and to motivate them to keep putting in place more and more nature-positive solutions. The carbon credits generated in Africa should come with an added value, delivering additional positive social benefits and improving people’s lives. Paying for such credits would allow farmers to keep improving the sustainability of their cropping systems but also help to break the vicious circle of poverty. In doing so, it will fulfil several Sustainable Development Goals and start the virtuous circle of prosperity as part of Africa’s green transition. And even though a recent study by the UN showed that almost 90% of the USD 540 bn in global subsidies given to farmers every year harm people and planet, the situation in Africa is different and a decent number of subsidies must be put towards nature-positive agricultural practices for the smallholder farmers.

If there is no policy to support farmers, all these efforts will be to no avail. Even though we can generate the best technology and innovation in universities and have the greatest start-up environment in the world, if farmers do not, or cannot, adopt it, the investments will have no impact. Farmers, especially smallholder farmers, do not damage soils or the environment in a conscious way. They do it because their priority is to take care of themselves and their family. In such situations, people just survive, using the tools and resources they have. If we want them to adopt new technologies to push for the green transition, it must come in a way that will improve their lives. These technologies, therefore, should help them to improve their productivity and attract business, to start changing from a vicious circle of environmental degradation to a virtuous circle of sustainable production and way of life. Having a viable business will allow them to change from receiving mode, where the State or other donors must provide or subsidise everything and where they usually have no voice; to active mode, where they now take control of their fate. If farmers cannot earn money and improve their lives, they will never have any incentive to adopt new technologies and ways of producing and will always depend on others.

However, there are major constraints in Africa that make it difficult for this to happen. First, Africa has a huge need for agriculture extension programmes, which should include basic financing and entrepreneurship education. Smallholder farmers must learn how to be entrepreneurs and to decide which technology to use and how. Once they learn this, they should have access to smart financing, which would allow them to adopt technologies and improve their production systems. This smart financing should focus on smallholder farmers, but green bonds should be more widely available to fund countries’ and companies’ green initiatives and projects. Farmers’ cooperatives should also be supported, as being part of a larger community gives more power to farmers, not only in terms of pricing and selling their products but also in having a voice. At the end of the supply chain, but no less important, they need market access to be able to sell their products easily. They also need access to an infrastructure to purchase goods and transport their production.

This policy should also give special attention to women and youth, who are important players in agriculture in Africa and the main drivers of innovation and technology adoption. African agriculture, for several
reasons, is in the hands of the older generation. For the changes discussed above to be successful, agriculture must be made attractive to Africa’s younger generation. Being able to make money, to have a good life, to have access to urban amenities and mechanisation to make work easier, among other things, will help the younger generation to see their future as farmers. But it is also important to make this new generation understand that they hold the green transformation of Africa in their hands, which will help build a better world. Many studies show that the new generation often prioritise purpose over salary, and that having a strong purpose in life is very important to them.

Finally, a strong sense of ethics should always be at the heart of Africa’s green transition. It is of utmost importance to ensure that the science we are producing will help, not threaten, our society. Not only should scientists advance their science in an ethical and responsible way, but a sense of ethics and responsibility should also be instilled in the African population. Only by respecting others, and our common assets like soils, water and forests, will we be able to take good care of our environment.

<table>
<thead>
<tr>
<th>SHORT TERM Year 1-2</th>
<th>MEDIUM TERM Year 3-5</th>
<th>LONG TERM Year 6-7</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFRICAN LIGHTHOUSES</td>
<td></td>
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</tr>
<tr>
<td>1st Lighthouse: UMAF</td>
<td>5th Lighthouse: AAB</td>
<td>9th Lighthouse: AUH</td>
</tr>
<tr>
<td>2nd Lighthouse: UCAD</td>
<td>6th Lighthouse: UING</td>
<td>10th Lighthouse: AUn</td>
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<tr>
<td>3rd Lighthouse: ICCC</td>
<td></td>
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<tr>
<td>4th Lighthouse: UNDOS</td>
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<tr>
<td>EXTENSION PROGRAMS</td>
<td>Training &amp; Dissemination</td>
<td>Training &amp; Dissemination</td>
</tr>
<tr>
<td>300 PROGRAM PhDs &amp; Postdocs</td>
<td>in parallel with the development of the lighthouses</td>
<td>in parallel with the development of the lighthouses</td>
</tr>
<tr>
<td>15x A-EU Dual Degree</td>
<td>40x A-EU Dual Degree</td>
<td>40x A-EU Dual Degree</td>
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<tr>
<td>30x A-EU Dual Degree</td>
<td>40x A-EU Dual Degree</td>
<td>10x A-EU Dual Degree</td>
</tr>
<tr>
<td>20%</td>
<td>20%</td>
<td>5%</td>
</tr>
<tr>
<td>INVESTMENT FRAMEWORK</td>
<td>Alignment with stakeholders to facilitate intercontinental and intercountry decisions</td>
<td>Starting in year 1 with including the history of previous investments &amp; initiatives</td>
</tr>
<tr>
<td></td>
<td>Observatories &amp; FAIR data management</td>
<td></td>
</tr>
</tbody>
</table>

Figure 31: Visualisation of roadmap for the short, medium and long term (by authors)
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GLOSSARY OF TERMS

Parts of the glossary of terms and the definitions used for this research work is based on "Challenges and opportunities for incubators in West Africa" produced in November 2018 by, the Organisation Internationale de la Francophonie, the World Bank Group, the Afric’innov Programme and Bond’innov, with contributions from the Tony Elumelu Foundation and Samir Abdelkrim (Organisation internationale de la francophonie et al. 2018).

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Agenda 2030</strong></td>
<td>The 2030 Agenda for Sustainable Development emphasises a “world free of poverty, hunger, disease and want ... free of fear and violence ... with equitable and universal access to quality education, health care and social protection ... to safe drinking water and sanitation ... where food is sufficient, safe, affordable and nutritious ... where habits are safe, resilient and sustainable ... and where there is universal access to affordable, reliable and sustainable energy.</td>
</tr>
<tr>
<td><strong>Agenda 2063</strong></td>
<td>Agenda 2063 is a set of initiatives proposed and currently under implementation by the African Union. It was adopted on 31 January 2015 at the 24th Ordinary Assembly of the Heads of State and Governments of the African Union in Addis Ababa.</td>
</tr>
<tr>
<td><strong>Alignment</strong></td>
<td>The result of donors basing their support on the country's national development strategies, institutions and processes, to make development funding more consistent and effective.</td>
</tr>
<tr>
<td><strong>Antimicrobial resistance (AMR)</strong></td>
<td>This occurs when bacteria, viruses, fungi and parasites change over time and no longer respond to medicines, making infections harder to treat and increasing the risk of disease spread, severe illness and death. As a result of drug resistance, antibiotics and other antimicrobial medicines become ineffective and infections become increasingly difficult or impossible to treat.</td>
</tr>
<tr>
<td><strong>Bioethics</strong></td>
<td>Refers to the ethical implications and applications of the health-related life sciences.</td>
</tr>
<tr>
<td><strong>Biospecimen</strong></td>
<td>A sample of material, such as urine, blood, tissue, cells, DNA, RNA, or protein, from humans, animals, or plants. Biospecimens may be used for a laboratory test or stored in a biorepository to be used for research.</td>
</tr>
<tr>
<td><strong>Brine</strong></td>
<td>Brine is a high-concentration solution of salt in water. In diverse contexts, brine may refer to the salt solutions ranging from about 3.5% up to about 26%. Brine forms naturally due to evaporation of ground saline water but it is also generated in the mining of sodium chloride.</td>
</tr>
<tr>
<td><strong>C footprint</strong></td>
<td>A carbon footprint is the total greenhouse gas emissions caused by an individual, event, organization, service, place or product, expressed as carbon dioxide equivalent.</td>
</tr>
<tr>
<td><strong>Capacity building</strong></td>
<td>The process of developing and strengthening the skills, processes and resources that an organisation, community or individual needs to operate efficiently.</td>
</tr>
<tr>
<td><strong>Circular economy</strong></td>
<td>A circular economy is &quot;a model of production and consumption, which involves sharing, leasing, renewing, repairing, refurbishing and recycling existing materials and products as long as possible&quot;. A CE aims to tackle global challenges like climate change, biodiversity loss, waste, and pollution by emphasizing design based implementation of the three base principles of the model.</td>
</tr>
<tr>
<td><strong>Clinical trials</strong></td>
<td>A prospective controlled study involving human subjects that is designed to answer specific questions about biomedical or behavioural interventions (such as drugs, treatments, or devices). In a randomised controlled trial (RCT),</td>
</tr>
</tbody>
</table>
participants are assigned by chance alone to either the control group or one or more intervention groups.

**Country ownership**

The ability of a country’s government, communities, civil society and private sector to lead, prioritise, implement and be accountable for a country’s policy response (here: in the field of health).

**Cover crops**

In agriculture, cover crops are plants that are planted to cover the soil rather than for the purpose of being harvested. Cover crops manage soil erosion, soil fertility, soil quality, water, weeds, pests, diseases, biodiversity and wildlife in an agroecosystem—an ecological system managed and shaped by humans. Cover crops may be an off-season crop planted after harvesting the cash crop.

**Data interoperability**

The ability of systems and services that create, exchange and consume data to have clear, shared expectations for the contents, context and meaning of that data.

**Data transparency**

Transparency is a core principle in data protection. People have the right to know which of their personal data are collected, used, consulted or otherwise processed and to what extent the personal data are or will be processed.

**Digital transformation**

The processes of using digital technologies to create new — or modify existing — business processes and customer/user experiences that meet changing business and market requirements.

**Entrepreneurial ecosystem**

The operational combination of factors that enables businesses to realise their strong growth potential. There are six main factors that define this environment: markets, human capital, accessibility and diversity of funding, regulation, culture and support systems.

**Fab lab**

Implementation of a new or significantly improved product (good or service) or process. It can take the form of a new method of marketing or a new organisational method for businesses, including the organisation of the workplace or external relations. The Oslo Manual includes four categories in its definition of innovation: product (good or service), process, organisation and marketing.

**Fintech**

Place open to the public and providing numerically controlled machine tools usually reserved for professionals, for the purpose of rapid prototyping or small-scale production. These “third places” (informal public gathering places) allow like-minded people to share their ideas, tools and skills.

**Genomic informed pathogen surveillance**

A genomics-based approach for pathogen surveillance informed by a ‘One Health’ concept, in which human, animal and environmental health are considered together.

**Global health**

An area for study, research, and practice that places a priority on improving health and achieving health equity for all people worldwide.

**Global health diplomacy**

Practice by which governments and non-state actors attempt to coordinate global policy solutions to improve global health.

**Hackathon**

Combining the terms “hacking” and “marathon,” a hackathon is an event where developers get together to do collaborative computer programming on a specific topic to create mobile applications or software.

**Health insurance**

A mechanism by which money is raised to pay for health services by financial contributions to a fund; the fund then purchases health services from providers for the benefit of those who are covered by the scheme. Health insurance contributions may be combined with a payment for other social benefits, in which case the scheme is called social insurance. The payments may be voluntary or compulsory.
| Health systems | The World Health Organization (WHO) defines health systems as the whole environment that comprises all organisations, institutions and resources whose primary purpose is to improve health. |
| Health systems research | Health policy and systems research is a multidisciplinary scientific field that provides evidence that can make healthcare affordable, safe, effective, equitable, accessible, and patient-centred. It seeks to understand and improve how societies organise themselves in achieving collective health goals, and how different actors interact in the policy and implementation processes to contribute to policy outcomes. By nature, it is interdisciplinary, a blend of economics, sociology, anthropology, political science, public health and epidemiology. |
| Human subject protection | Policies, procedures and ethical considerations that protect the rights and welfare of people who participate in research as subjects. |
| Implementation research | The scientific inquiry into questions concerning implementation—the act of carrying an intention into effect, which in health research can be policies, programmes or individual practices (collectively called interventions). |
| Innovation | Traditionally it takes place in a 48-hour format, and at the end of the event each team makes a short presentation on their project. |
| Intersectionality | The interconnected nature of social categorisations such as race, class, and gender, regarded as creating overlapping and interdependent systems of discrimination or disadvantage. |
| Intervention | In the field of public health, this term describes a programme or policy that affects change on a health problem. In global health, for example, delivering insecticide-treated bed nets is an intervention designed to reduce the incidence of malaria. Health interventions can be grouped into the following categories: health promotion, specific protection, early case finding and prompt treatment, disability limitation, and rehabilitation. In clinical medicine, an intervention is usually undertaken to treat or cure a condition. |
| Key performance indicators | A well-defined performance measure that is used to observe, analyse, optimise, and transform a healthcare process to increase satisfaction for both patients and healthcare providers alike. |
| Life course approach | An approach suggesting that the health outcomes of individuals and the community depend on the interaction of multiple protective and risk factors throughout people’s lives. This approach provides a more comprehensive vision of health and its determinants, which calls for the development of health services more centred on the needs of users in each stage of their lives. |
| Millennium Development Goals (MDGs) | A set of eight goals and corresponding time-bound targets to improve health and the standard of living globally by 2015, adopted by all 189-member states in 2000. |
| Monitoring | The continuous oversight of an activity to assist in its supervision and to see that it proceeds according to plan. Monitoring involves the specification of methods to measure activity, use of resources, and response to services against agreed criteria. |
| National Health Strategic Plan | Refers to the broad, long-term lines of action to achieve the policy vision and goals for the health sector, incorporating “the identification of suitable points for intervention, the ways of ensuring the involvement of other sectors, the range of political, social, economic and technical factors, as well as constraints and ways of dealing with them” |
| Next generation sequencing (NGS) | A high-throughput method used to determine a portion of the nucleotide sequence of an individual’s genome. This technique utilises DNA sequencing |
technologies that are capable of processing multiple DNA sequences in parallel. Also called massively parallel sequencing.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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</thead>
<tbody>
<tr>
<td>Non-communicable diseases</td>
<td>Also known as chronic diseases, tend to be of long duration and are the result of a combination of genetic, physiological, environmental and behavioural factors.</td>
</tr>
<tr>
<td>No-till systems</td>
<td>No-till practices allow the soil structure to stay intact and also protect the soil by leaving crop residue on the soil surface. Improved soil structure and soil cover increase the soil's ability to absorb and infiltrate water, which in turn reduces soil erosion and runoff and prevents pollution from entering nearby water sources.</td>
</tr>
<tr>
<td>Open science</td>
<td>The movement to make scientific research, data and its dissemination available to any member of society, from professionals to private individuals.</td>
</tr>
<tr>
<td>Pandemic preparedness</td>
<td>Continuous process of planning, exercising, revising and translating into action national and sub-national pandemic preparedness and response plans. A pandemic plan is thus a living document which is reviewed regularly and revised if necessary, for example based on the lessons learnt from outbreaks or a pandemic, or from a simulation exercise.</td>
</tr>
<tr>
<td>Pharmacovigilance</td>
<td>The science and activities relating to the detection, assessment, understanding and prevention of adverse effects from pharmaceutical products, or any other medicine/vaccine related problem.</td>
</tr>
<tr>
<td>Precision medicine</td>
<td>The use of specific information about an individual to facilitate a more precise approach to their healthcare.</td>
</tr>
<tr>
<td>Primary healthcare</td>
<td>In global health, refers to a broader context than having care coordinated by primary healthcare providers, such as physicians and nurse practitioners. According to the WHO, the 1978 Alma-Ata Declaration was the “first international declaration advocating primary healthcare as the main strategy for achieving WHO’s goal of ‘health for all.’” In the declaration, primary health care is defined as, “essential healthcare based on practical, scientifically sound and socially acceptable methods and technology made universally accessible to individuals and families in the community through their full participation and at a cost that the community and country can afford to maintain at every stage of their development, in the spirit of self-reliance and self-determination.”</td>
</tr>
<tr>
<td>Sabkhas</td>
<td>A term typically used by Earth scientists, a sabkha is a coastal, supratidal mudflat or sandflat in which evaporite-saline minerals accumulate as the result of semiarid to arid climate. Sabkhas are gradational between land and intertidal zone within restricted coastal plains just above normal high-tide level.</td>
</tr>
<tr>
<td>Scaling up</td>
<td>According to the WHO, scaling up is defined as deliberate efforts to increase the impact of health service innovations so as to benefit more people and to promote policy and programme development on a lasting basis.</td>
</tr>
<tr>
<td>Situation analysis</td>
<td>Analysis of the current status and expected trends in a country's health and health system.</td>
</tr>
<tr>
<td>Social business</td>
<td>Refers to an innovative start-up that leverages technology to rethink financial and banking services</td>
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<tr>
<td>Social determinants of health</td>
<td>Refer to “conditions in the places where people live, learn, work, and play [that] affect a wide range of health risks and outcomes.”</td>
</tr>
<tr>
<td>South-South collaboration</td>
<td>Technical cooperation among developing countries in the Global South.</td>
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</tbody>
</table>
**Stakeholders**
A stakeholder is a person, group or organization that has direct or indirect interest in another organisation because it can affect or be affected by that organisation's actions, objectives, and policies.

**Start-up**
A way of doing business that places economic efficiency at the service of society and the environment. Social businesses provide innovative solutions to unresolved social and/or environmental challenges by combining impact and economic efficiency.

**Surveillance**
A key component of epidemiology, it can be defined as the ongoing collection, analysis, interpretation, and dissemination of health-related data. Surveillance is one of a number of methods used by epidemiologists to gather information on a disease.

**Sustainability**
"Sustainability can refer to four major outcomes:

1) Continuing the project activities within the funded organisation that were developed and implemented during the period of the external grant funding;

2) Sustaining benefits for intended clients;

3) Maintaining the capacity of a collaborative structure, such as a coalition;

4) Maintaining attention to the issues addressed by the programme, including processes that continue advocacy efforts or that help to spread the concepts or beliefs underlying a programme."

**Sustainable Development Goals (SDGs)**

1) Continuing the project activities within the funded organisation that were developed and implemented during the period of the external grant funding;

2) Sustaining benefits for intended clients;

3) Maintaining the capacity of a collaborative structure, such as a coalition;

4) Maintaining attention to the issues addressed by the programme, including processes that continue advocacy efforts or that help to spread the concepts or beliefs underlying a programme."

**Tech hub**
2) Sustaining benefits for intended clients;

**Technical assistance**
3) Maintaining the capacity of a collaborative structure, such as a coalition;

**Telemedicine**
4) Maintaining attention to the issues addressed by the programme, including processes that continue advocacy efforts or that help to spread the concepts or beliefs underlying a programme."

**Transdisciplinary research**
The Sustainable Development Goals or Global Goals are a collection of 17 interlinked global goals designed to be a "blueprint to achieve a better and more sustainable future for all". The SDGs were set up in 2015 by the United Nations General Assembly and are intended to be achieved by the year 2030.

**Triple billion targets**
An innovative company which has a strong development potential, and which therefore requires significant investments to be able to finance its rapid growth

**Universal health coverage**
A type of aid designed to provide less-developed countries with the expertise needed to promote development. It may involve sending experts into the field to teach skills and to help solve problems in their areas of specialisation. Or scholarships, study tours and seminars in developed countries, attended by individuals from less-developed countries.

**Zoonotic diseases**
A term coined in the 1970s, which literally means “healing at a distance”, signifies the use of ICT to improve patient outcomes by increasing access to care and medical information.
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>4IR</td>
<td>Fourth Industrial Revolution</td>
</tr>
<tr>
<td>AAA</td>
<td>Adaptation of African Agriculture</td>
</tr>
<tr>
<td>AAS</td>
<td>African Academy of Sciences</td>
</tr>
<tr>
<td>AAU</td>
<td>Addis Ababa University</td>
</tr>
<tr>
<td>ACDC</td>
<td>African Centre for Disease Control and Prevention</td>
</tr>
<tr>
<td>ACP</td>
<td>African, Caribbean and Pacific States</td>
</tr>
<tr>
<td>AEIP</td>
<td>Africa - Europe Innovation Partnership</td>
</tr>
<tr>
<td>AERAP</td>
<td>Africa-Europe Science Collaboration Astronomy Platform</td>
</tr>
<tr>
<td>AESA</td>
<td>Alliance for Acceleration of Sciences in Africa</td>
</tr>
<tr>
<td>AfCFTA</td>
<td>African Continental Free Trade Area</td>
</tr>
<tr>
<td>AfCTA</td>
<td>African Continental Free Trade Area</td>
</tr>
<tr>
<td>AFD</td>
<td>Agence Française de Développement</td>
</tr>
<tr>
<td>AFTCOR</td>
<td>African Task Force for Coronavirus</td>
</tr>
<tr>
<td>AG</td>
<td>Advisory Group</td>
</tr>
<tr>
<td>AIM</td>
<td>International Association of Mutuals</td>
</tr>
<tr>
<td>AKU</td>
<td>Aga Khan University</td>
</tr>
<tr>
<td>AMA</td>
<td>African Medicines Agency</td>
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<tr>
<td>AMR</td>
<td>Antimicrobial resistance</td>
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<tr>
<td>AMRH</td>
<td>African Medicines Regulatory Harmonization</td>
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<td>APNI</td>
<td>African Plant Nutrition Institute</td>
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<td>APRA</td>
<td>Agricultural Policy Research in Africa), and AAA (Adaptation of African Agriculture Initiative</td>
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<td>ARISE</td>
<td>African Research Initiative for Scientific Excellence</td>
</tr>
<tr>
<td>ASP</td>
<td>Africa's Scientific Priorities Programme</td>
</tr>
<tr>
<td>AU</td>
<td>African Union</td>
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<tr>
<td>AU HRST</td>
<td>Human Resources, Science and Technology of the African Union</td>
</tr>
<tr>
<td>AU STC-HPDC</td>
<td>African Union Specialised Technical Committee on Health, Population and Drug Control</td>
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<tr>
<td>AUC</td>
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<td>AUDA-NEPAD</td>
<td>The development agency of the African Union</td>
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<td>Abbreviation</td>
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<td>AUN</td>
<td>Assiut University</td>
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<td>AVAREF</td>
<td>African Vaccine Regulatory Forum</td>
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<td>CARI</td>
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<tr>
<td>CCSE</td>
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<td>CGIAR</td>
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<td>COE</td>
<td>Center of excellence</td>
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<td>COHRED</td>
<td>Coalition for Health Research and Development</td>
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<tr>
<td>CONFER</td>
<td>Co-production of Climate Services for East Africa</td>
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<tr>
<td>CORDIS</td>
<td>Community Research and Development Information Service</td>
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<td>DeSIRA</td>
<td>Development Smart Innovation through Research in Agriculture</td>
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<td>DG</td>
<td>Directorate General</td>
</tr>
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<td>DG INTPA</td>
<td>European Commission department for International Partnerships</td>
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<td>DG RTD</td>
<td>European Commission department for department for R&amp;I</td>
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<td>DLR</td>
<td>Deutsches Zentrum für Luft- und Raumfahrt</td>
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<td>DNDi</td>
<td>Drugs for Neglected Diseases initiative</td>
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<td>DSW</td>
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<td>ECDC</td>
<td>European Centre for Disease Prevention and Control</td>
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<td>EDCTP</td>
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<td>Food and Nutrition Security and Sustainable Agriculture</td>
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<td>Framework Programme</td>
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<td>Gross Domestic Product</td>
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<td>Group on Earth Observations</td>
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<td>ICPD</td>
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<td>INTPA</td>
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<td>JRC</td>
<td>Joint Research Council</td>
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<td>New Partnership for Africa’s Development</td>
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<td>Organisation for Economic Co-operation and Development</td>
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<td>Qualitative comparative analysis</td>
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<td>Regional Centres of Regulatory Excellence</td>
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<td>Research, development and innovation</td>
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<td>RIIP</td>
<td>Institut Pasteur International</td>
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<td>Southern African Development Community</td>
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<td>Specific Measurable Achievable Reasonable Time-Bound</td>
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<td>Small and medium-sized enterprises</td>
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<td>University of Cape Coast</td>
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<td>University of Cape Town</td>
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<td>Université Marien Ngouabi</td>
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<td>United Nations</td>
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<td>UNESCO</td>
<td>United Nations Educational, Scientific and Cultural Organisation</td>
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<td>UniJos</td>
<td>University of Jos</td>
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<td>USD</td>
<td>US Dollar</td>
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<td>World Health Organization</td>
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<td>WHO AFRO</td>
<td>World Health Organisation Regional office for Africa</td>
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<td>WTO</td>
<td>World Trade Organization</td>
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<td>4IR</td>
<td>Fourth Industrial Revolution</td>
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SUPPLEMENTARY FIGURES

Health

Supplementary figure 1: Public health systems in Africa (Africa Center for Strategic Studies 2020)

Supplementary figure 2: Open Science: Openness through all stages of the research cycle (Bertero 2020)
R&I capacities

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<th>Answer</th>
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<th>Percentage</th>
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<tr>
<td>Male (M)</td>
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<td>50.00%</td>
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Supplementary Figure 3: Representation of respondents by gender (by authors)

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<th>Country</th>
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<td>3.33%</td>
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<tr>
<td>Great Britain</td>
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<td>3.33%</td>
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<tr>
<td>Italy</td>
<td>1</td>
<td>3.33%</td>
</tr>
<tr>
<td>Kenya</td>
<td>1</td>
<td>3.33%</td>
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<td>Libya</td>
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<td>3.33%</td>
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<tr>
<td>Mozambique</td>
<td>1</td>
<td>3.33%</td>
</tr>
<tr>
<td>Netherlands</td>
<td>1</td>
<td>3.33%</td>
</tr>
<tr>
<td>Nigeria</td>
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<td>3.33%</td>
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<tr>
<td>South Africa</td>
<td>20</td>
<td>66.67%</td>
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<tr>
<td>Sudan</td>
<td>1</td>
<td>3.33%</td>
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<tr>
<td>Switzerland</td>
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<td>3.33%</td>
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Supplementary Figure 4: Representation of respondents by country (by authors)

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<td>Policymaker</td>
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<td>Entrepreneur</td>
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<td>Institution</td>
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<td>Government</td>
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<td>Private sector</td>
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<td>NGO</td>
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<td>Research organisation</td>
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Supplementary Figure 5: Representation of respondents by field of work (by authors)

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<td>40.00%</td>
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<tr>
<td>Yes, Can you send me the follow-up questionnaire and I will respond in writing</td>
<td>15</td>
<td>50.00%</td>
</tr>
<tr>
<td>No, thank you</td>
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<td>6.67%</td>
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<tr>
<td>Other</td>
<td>1</td>
<td>3.33%</td>
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Supplementary Figure 6: Preliminary results of number of responses and preferred method of follow-up communication (by authors)
Technology and Innovation

Supplementary Figure 7: Volume of funds raised by African tech and mobile penetration in Africa (GSMA 2019; Partech Partners 2020)

Supplementary Figure 8: Tech initiatives against Covid-19 documented on the African continent (February 2020-March 2021). Number of initiatives per country. 306 initiatives documented in total (by authors)
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<th>Kenya</th>
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<td>18 Waste management</td>
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<td>19 Built environment</td>
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<td>21 Social research</td>
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Supplementary Figure 9: Project focus areas per country (by authors)
INTERVIEW GUIDELINES

Health

The guide below is for a semi-structured interview used for the Zoom interviews conducted between June and July 2021 with KIIs. The duration of each interview was approximately 1-hour long.

AU-EU Cooperation

1. Kindly introduce yourself and the role you play at your organisation.
   • How are you engaged in the healthcare ecosystem?
   • How is your organisation engaged in R&I for health systems in Africa?
   Now let’s talk a little about AU-EU cooperation in health systems.

2. What have been the success factors for in R&I for health systems between the AU and EU cooperation?
   • Which projects/policies have successfully enabled cooperation (in R&I for health systems) between the AU and the EU in the past?
   • What are the major challenges and limitations of this cooperation?

3. How best could the AU and the EU promote cooperation in R&I for health systems in Africa?
   • Where do you see potential for better collaboration between the two regional bodies with regards to health systems?

Health Systems

4. What has been the impact of research and innovation in building resilient health systems in Africa so far?
   • How is the African Union implicated in R&I for health systems?
   • How does this compare to the role of the European Union?
   • What would you suggest as the way forward / strategy for future health systems?

Ethics and Regulatory frameworks

5. How would you describe the current and future ethics and regulatory landscape for health systems in Africa?
   • What would you say is working so far in terms of Ethics and Regulatory frameworks for health systems in Africa?
   • What are the limitations (and opportunities for improvement) while reinforcing an ethics and regulatory framework for health systems in Africa?
   • Which key institutions come to mind when thinking about health systems ethics and regulation in Africa?

Knowledge translation: Bridging policy and research

6. What is the relation between research and policy with regards to health systems in Africa?
   • How has health systems research been translated into policy on the African continent so far?
   • What have been the loopholes in bridging the gap between research and policy for health systems in Africa?
   • What would you say is the future of health systems policy and decision making on the African continent?
R&I Capacities

Questions covered in the survey:

1. Personal information: Title, Name and surname, Gender, Position, Country, Field of work (area of work) – researcher, policymaker, innovator, entrepreneur, institution, government, private sector, NGO, university, research organisation
2. Are you aware of the EU-Africa R&I partnership?
3. Have you benefited from the EU-Africa R&I partnership?
4. Are you aware of the High-Level Policy Dialogue (HLPD) under the EU-Africa cooperation in R&I?
5. Are you aware of the funding instruments under the EU-Africa cooperation in R&I?
6. Are the AU research grants effective in supporting R&I capacities in Africa?
7. Can we contact you for a follow-up survey?

Questions covered in the virtual interviews:

1. Need to define a R&I agenda for Africa?
2. Emerging policy issues and technologies?
3. Funding for R&I?
4. Education linked to STI (digital technologies, e-learning)?
5. Infrastructure – connectivity?
6. Are you aware of the HLPD under the EU-Africa cooperation in R&I?
7. In your opinion, is the HLPD effective? If Yes, in what way?
8. How can STI policy and governance capacities be improved in Africa?
9. How can STI support implementation of 2030 SDGs?
10. How can STI help advance Agenda 2063?
11. How can Africa’s participation be improved in the EU’s framework programme for R&I?
12. How can human and institutional capacities in STI be developed and improved in Africa?
13. How can public private/industry and academia linkages and partnerships be improved in R&I in Africa?
14. How can start-ups be supported in Africa?

Questions covered in the Marie Skłodowska-Curie actions (MSCA) in the interview that were answered through virtual consultations:

1. Analysis of Africa’s participation in MSCA?
2. Explanations on different actions and participation in them?
3. Reasons for low and high participation?

URL link to the survey:
https://d38rqs2egh08o4.cloudfront.net/link_click/p65eqRZKcU_hn5Vu/d3694c85fa20dc2d83ce5bbcfc34b675
## EXAMPLES OF BEST PRACTICE IDENTIFIED FOR THE EMERGENCE OF THE AFRICAN DIGITAL REVOLUTION

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<th>SECTOR/BODY</th>
<th>COUNTRY</th>
<th>BEST-PRACTICE</th>
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<td>Tech hub development</td>
<td>Ghana</td>
<td><strong>MEST</strong>&lt;br&gt;Both a computer science academy and a start-up incubator, MEST trains, incubates and invests in start-ups. MEST launched a two-year programme to create talented digital entrepreneurs and train them to master different computer programming languages, build business plans, create monetizable services on the internet, generate revenue, and pitch.&lt;br&gt;At the end of the two years, they pass an exam: the final pitches in front of the jury, mainly business angels and entrepreneurs from Silicon Valley. If they succeed in demonstrating their business is viable and thus convince the jury, they receive an investment of up to US$520,000.</td>
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<td>Tech hub development</td>
<td>Senegal &amp; Niger</td>
<td><strong>CTIC &amp; CIPMEN</strong>&lt;br&gt;The CTIC is the result of a strong impetus from the private sector, which wanted to accelerate the development of ICT in Senegal. Public-private partnerships subsequently strengthened the CTIC's offer, designed to increase the chances of survival of the start-ups it supports. Those incubated by the CTIC are still in operation after 3 years, and their turnover increases on average by 41% year on year.&lt;br&gt;In 2014, Niger created the CIPMEN incubator, directly inspired by CTIC Dakar, especially its economic model, public-private governance, and incubation methods. CIPMEN started supporting Nigerian start-ups specializing in information technology</td>
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<td>Corporate engagement</td>
<td>Panafriican (Ghana, Tunisia, South Africa)</td>
<td><strong>MICROSOFT</strong>&lt;br&gt;In 2013, the multinational launched the 4Afrika initiative to accelerate Africa's digital transition, digitisation and technological advancement by investing in start-ups, partners, and governments. Microsoft has trained 15,000 teachers, reached over 1 million students, created over 1,800 jobs, and supported 35 successful start-ups in Ghana&lt;br&gt;Since 2007, Microsoft Tunisia has sponsored Tunisian start-ups who obtain technical and managerial training provided by national and international experts, advice and coaching.&lt;br&gt;The sponsorship programme merged in 2014 with Tunisian Start-up factory.&lt;br&gt;The company will have helped create 60 projects in 6 years of existence.&lt;br&gt;Microsoft South Africa launched 'Head Start' in November 2018, an end-end programme boosting tech start-ups by giving them open access to wide-ranging skills development resources, coaches and mentors, a fully-fledged customer network, and the platform on which to build their products and services</td>
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<td>Corporate engagement</td>
<td>South Africa</td>
<td><strong>MTN</strong>&lt;br&gt;The company organizes the MTN Entrepreneurship Challenge every year during the MTN Entrepreneurship Festival in Cape Town, a pan-African competition that rewards start-ups from across the continent with US$75,000 in funding.&lt;br&gt;In particular, the winner has the opportunity to be incubated at the MTN Solution Space, born out of a partnership between MTN and the University of Cape Town Graduate School of Business in 2014.</td>
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<td>Venture capitalists &amp; business angels</td>
<td>Senegal</td>
<td><strong>TERANGA CAPITAL</strong>&lt;br&gt;In the early 2000s, Investisseurs &amp; Partenaires was the first fund whose investment strategy targeted Africa and companies, particularly small and medium firms. Omar Cissé and Olivier Furdelle then founded Teranga Capital in 2016, with I&amp;P as an investor, to create the first Senegalese venture capital fund focused on seed capital.&lt;br&gt;The investment fund, dedicated to small firms, combines two essential components: financial engineering and entrepreneurial support, to step out of a purely financial approach and build a five-year development project with the companies they invest in.</td>
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<td>Venture capitalists &amp; business angels</td>
<td>Panafriican</td>
<td><strong>ABAN</strong>&lt;br&gt;Each ABAN (African Business Angels Association) member must invest a minimum of US$5,000 per year in African start-ups. Tickets are often shared with other co-investors to dilute risk taking. Each business angel must dedicate a minimum of 20 days per year to coaching entrepreneurs, thus becoming associate-entrepreneurs involved in the success of the projects.</td>
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<td>Public policies</td>
<td>Tunisia</td>
<td><strong>START-UP ACT</strong>&lt;br&gt;Discussions started around 2015, after an “open letter” from the major players in the tech organisation sector to the ministry of Ecology, and were finally acted on three years later, in 2018.&lt;br&gt;The whole process was a real multi-stakeholder initiative. Some of the best measures are as follows: the state pays for the start-up's salary and employer costs, as well as the costs of registering its patents both nationally and internationally.&lt;br&gt;The Tunisian Start-up Act also allows entrepreneurs to take a year off to dedicate themselves entirely to their business project. Tax deductions for investors also make financing Tunisian start-ups more attractive and advantageous for venture capitalists.</td>
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Policy Study<br>Advisory Group on R&I for Africa-Europe Cooperation
The first-year assessment of the Tunisian Start-up Act revealed that 248 companies had benefitted from the Start-up Label, with positive results: they hired 2,829 people and enjoyed cumulative turnover of USD23.7 million in 2019.

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<th>Public policies</th>
<th>Morocco</th>
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<td><strong>PUBLIC PLANS</strong></td>
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<td>2 plans labelled « MAROC NUMÉRIQUE » succeeded from 2009-11 and 2015-20 in their objective of structuring the tech ecosystem, based on offshoring. The ecosystem today represents MAD 14 billion in exports and more than 100,000 jobs, with the emergence of major players such as HPS: a company of electronic money valued at EUR100 million or INTELCIA, with call centres set up in many countries.</td>
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<td>The public tech ecosystem also has many active organisations, such as CCG (Caisse centrale de garantie) and ADD (Agence de Développement du Digital), UM6P, which holds entrepreneurship programmes and CDG (Caisse de Dépôt et de Gestion du Maroc), which launched 212 Founders. But also, some policies, like INNOV INVEST, with the creation of 3 investment funds endowed with European 100 million, creating a first, decisive deal flow pipeline.</td>
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### EXAMPLES AND CONCRETE INITIATIVES FROM 306 “AFRICAN TECH INITIATIVES AGAINST COVID” MAPPING

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<th>SECTOR/BODY</th>
<th>COUNTRY</th>
<th>BEST PRACTICE</th>
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<td>[JL1] Complementary services developed by health-techs to tackle challenges arising from the Covid crisis</td>
<td>Nigeria</td>
<td><strong>AIRBANK</strong>&lt;br&gt;Airbank is an on-demand emergency medical oxygen delivery service powered by LifeBank, a renowned start-up leading the e-health transformation in Nigeria. The company, founded in 2016 by Temie Giwa-Tubosun, aims to facilitate access to medical supplies through lifesaving, tech-led medical product distribution services in the country. Facing oxygen shortages throughout the region due to high demand caused by COVID-19, LifeBank developed AirBank, the quickest, most convenient and cost-effective way to order medical oxygen in cylinders. According to the Founder, T. Giwa-Tubosun, AirBank has provided over 100 units of 6cml of medical oxygen to isolation centres treating COVID-19 patients, in 3 regions in Nigeria: Lagos, Kano and Oyo States, saving over 400 lives.</td>
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<td>Mobile money powering universal income scheme to fight economic constraints imposed by the pandemics</td>
<td>Togo</td>
<td><strong>NOVISSI</strong>&lt;br&gt;The Novissi Programme aims to support workers from the informal sector who were particularly affected by health restrictions such as lockdowns, curfew and social distancing during the Covid-19 pandemics. Four payment sessions were organised, reaching a total of 567,002 beneficiaries at their peak and 456,420 at the lowest, for an average of 2 to 3 billion CFA francs per tranche. In total, more than 13 billion CFA francs were disbursed by the Togolese government, or USD23 million. Programme enrollees and beneficiaries represent 17.4% and 7.1% of the Togolese population respectively. Women account for 62% of the total number of beneficiaries. Novissi is based on monthly transfers amounting to €15 for men and €20 for women. In a country where the minimum wage is €53, it is a real safety net for informal workers. The use of digital, and more specifically mobile money proved critical in implementing such a programme, as the country has low rates of bank penetration. Moreover, the informal status of the workers made them reluctant to use state programmes, while the mobile money scheme enabled beneficiaries to remain anonymous.</td>
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<td>Interactive voice service offers an access for all to Covid 19-related information</td>
<td>Niger</td>
<td><strong>STOP CORONA 701</strong>&lt;br&gt;Interactive voice service through a mobile app that aims to communicate important Covid-19 messages to people without internet access. The app allows all subscribers of these four mobile operators to dial the number 701 for free, to access a broad range of COVID-19 messages. The information is given in 4 of Niger’s main indigenous languages: Zarma, Haoussa, Fulfude and Kanuri, as well as French. This was developed by Daouda Hamadou – an honouree of the Young African Leadership Initiative (YALI), in collaboration with three Nigerien start-ups: NOVATECH, Dev4 Smart and Visicom. The innovation enjoys the support of the National Agency for the Information Society (ANSI), Niger’s Ministry of Health, and four of the country’s mobile telephone operators. As of September 2020, they had handled over 26,000 calls from across Niger. The platform has helped thousands of rural Nigerians by enabling them to access vital information on COVID-19 with just their phone, without requiring internet access.</td>
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This policy study is authored by the Advisory Group (AG) on R&I for Africa-Europe cooperation commissioned by the European Commission’s Directorates-General for Research and Innovation and for International Partnerships.

The document presents the group’s findings on how to best mainstream and boost R&I cooperation with African partners in the field of (1) health, (2) R&I capacities, (3) technology and innovation and (4) green transition. It discusses the state of play of each topic and highlights the key findings and recommendations for strengthening the cooperation, including concrete recommendations for future actions. It highlights the need for a balanced, respectful, transparent, visible and efficient partnership that follows the principles of good governance and high ethical standards. The recommendations recognise the need for increased investments in institutional capacities and training; R&I policy and governance; infrastructure and institutions; human capacity development; knowledge management and funding; and cooperation and partnerships.

Studies and reports