Evaluation Report

Review of Rwanda's National Science, Technology, and Innovation Policy and Recommendations for Strategy

2013

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Acknowledgements

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Foreword

There is a strong recognition within Rwanda relating to the importance of Science and Technology to the Nation's development and economic growth. The principles enshrined in Rwanda's Vision 2020 guide the National Vision of Rwanda for the Promotion of Science, Technology and Scientific Research, namely to support Rwanda as she "becomes a modern nation, able to generate and disseminate technological knowledge and innovation."

In 2005 the Cabinet approved a National Policy on Science Technology and Innovation with the mission of "integrat[ing] Science, Technology, Scientific Research and Innovation in a framework that … [serves as a] catalyst underpin all public and private sector activities to enable Rwanda's Vision 2020 to be realised."

One of the key objectives of the Science, Technology and Innovation Policy is to help overcome challenges that cut across all sectors of the economy, and all aspects of society. These include to support the growth of the economy of Rwanda, advance the quality of life for all the citizens of Rwanda, and to improve the skills and knowledge among the population, specifically to create a "knowledge-based" economy. The aim is for the development of Science, Technology, and Innovation to be in partnership with the growth of an innovative, modern and competitive private sector geared towards revival of industry and the service sector.

It is now almost eight years since the policy was adopted. The Directorate General of Science, Technology and Research (DSTR) and the National Commission of Science and Technology (NCST) recognize a need to evaluate how the policy objectives have been implemented on the ground in Rwanda, specifically to identify any successes or gaps in the implementation. We are very grateful for the support of UNECA who commissioned the Global Knowledge Initiative (GKI) to undertake the study.

We look forward to the outcomes of this evaluation report, which will support DSTR and NCST in drafting an updated National Science, Technology and Innovation Policy. This will also form the basis of the preparation of a five-year strategic plan for the implementation of the updated policy in consultation with all Science, Technology, Research, and Innovation stakeholders in Rwanda.

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Minister of Education

Republic of Rwanda

Abbreviations

BDC	Business Development Centers
BDS	Business Development Services
CITT	Center for Innovation and Technology Transfer
DSTR	Directorate of Science, Technology, and Research
EAC	East African Community
EDPRS	Economic Development and Poverty Reduction Strategy
GDP	Gross Domestic Product
GKI	The Global Knowledge Initiative
HEC	National Council for Higher Education
HLI	Higher learning institution
ICT	Information and communication technologies
IP	Intellectual property
JICA	Japanese International Cooperation Agency
KIE	Kigali Institute of Education
KIST	Kigali Institute of Science and Technology
KTP	Knowledge Transfer Partnership
M&E	Monitoring and evaluation
MINAGRI	Ministry of Agriculture and Animal Resources
MINEDUC	Ministry of Education
MINECOFIN	Ministry of Finance and Economic Planning
MINICOM	Ministry of Trade and Industry
MYICT	Ministry of Youth and Information and Communications Technology
MINISTR	Ministry of Science, Technology, and Scientific Research (former)
NCST	National Commission of Science and Technology
NUR	National University of Rwanda
PSF	Private Sector Federation
R&D	Research and development

RAB	Rwanda Agriculture Board
RBS	Rwanda Bureau of Standards
RDB	Rwanda Development Board
REMA	Rwanda Environment Management Authority
RIEF	Rwanda Innovation Endowment Fund
SIDA	Swedish International Development Cooperation Agency
SME	Small and medium-sized enterprise
S&T	Science and technology
STI	Science, technology, and innovation
TBIF	Technology and Business Incubation Facility
TVET	Technical and Vocational Education and Training
UNECA	United Nations Economic Commission for Africa
UNESCO	United Nations Educational, Scientific, and Cultural Organization
USAID	United States Agency for International Development
WEF	World Economic Forum

Photo: Downtown Kigali; Credit: Global Knowledge Initiative

Executive Summary

Rwanda's guiding policy document, Vision 2020, sets ambitious goals and targets for the country's socio-economic transformation, including raising annual per capita income from $200 to $900, and halving the poverty rate. Science, technology, and innovation (STI) represent "indispensible" tools for helping Rwanda achieve these targets (STI Policy, 2005). STI in the form of improved crop varieties, better trained medical professionals, and enhanced local manufacturing capacity constitute vital inputs to social and economic progress in Rwanda. However, STI have been chronically underutilized as tools for development (STI Policy, 2005). The 2005 STI Policy aims to provide a framework for boosting the contribution of STI to Vision 2020 achievement.

In April 2013, the Ministry of Education (MINEDUC) and its Directorate of Science, Technology, and Research (DSTR) initiated a review of the 2005 STI Policy in partnership with the UN Economic Commission for Africa (UNECA). MINEDUC and UNECA invited the Global Knowledge Initiative, an international non-profit organization that specializes in promoting STI for development, with support from a local consultant, to perform the review. Specifically, the review team was asked to evaluate how the STI Policy's objectives have been implemented on the ground in Rwanda, identify specific successes or gaps in implementation, and make recommendations for a possible update of the Rwanda STI Policy itself. MINEDUC and UNECA facilitated the review process by providing historical background on the STI Policy and its implementation; assisting in outreach to key stakeholders for interviews; and hosting two stakeholder workshops (May and June 2013) that informed the review process.

The review of the 2005 STI Policy is warranted at this juncture for a number of reasons. First, 2013 represents a rough mid-point between the introduction of the policy in 2005, and the culmination of Vision 2020. STI proponents need to understand what has and has not been working in terms of STI Policy implementation to effectively course-correct before the 2020 horizon. Second, the STI Policy was authored before Rwanda introduced the rigorous planning and benchmarking processes featured in national planning instruments such as the Economic Development and Poverty Reduction Strategy (EDPRS). The STI Policy does not include an actionable implementation plan or monitoring and evaluation (M&E) framework, which has become a mainstay in Rwanda's policy planning process in the years since 2005. This review offers an important pivot point from which to introduce a clear implementation plan and targets for progress. Indeed, the policy review will be immediately followed up with an update of the STI Policy and the crafting of an STI Policy strategic implementation plan, inclusive of an M&E framework. This work will be led by MINEDUC with support from UNECA and the National Commission of Science and Technology (NCST).

Taking a systems-based approach, the four-person research team looked across and within four essential and inter-related pillars of STI: Knowledge Acquisition, Knowledge Creation, Knowledge Transfer, and Innovation Culture. The four-pillar structure, which mirrors the organization of the STI Policy, and the major trends and findings for each are listed below and discussed in greater detail in the following sections. The findings and considerations for STI Policy reform were designed both to prompt informed discussion during a June 2013 Policy Dialogue, and to serve as a springboard toward longer-term strategy formulation. The chapters—each of which addresses one pillar in turn—provide case studies and discussion specific to each.

STI Policy Pillar I: Knowledge Acquisition

- Rwanda characterized by high-level commitment to STI-based education, as illustrated by a progressive scholarship scheme for STI-based studies
- Women and girls achieving increased access to STI-based education and careers

- Lack of practical exposure through STI-based education hinders relevance and employability of graduates
- Rwanda not yet able to meet demands for engineers and PhD-level STI professionals, though numbers are increasing

STI Policy Pillar II: Knowledge Creation
- Agricultural research illuminates how Knowledge Creation can accelerate sectoral development
- Sub-optimal incentives and metrics for research impede research productivity
- Mismatch between research outputs and market needs hinders potential impact
- Forthcoming research policy, if well designed, bodes well for clarifying the current ambiguity on research

STI Policy Pillar III: Knowledge Transfer
- Inadequate commercialization and communication of research results hinders potential benefits
- Interaction with global knowledge network could be strengthened
- Boosting opportunities for industrial attachment and mentorship for students a high priority across sectors
- Greater focus on enabling knowledge transfer functions warranted

STI Policy Pillar IV: Innovation Culture
- Growing constellation of innovation and entrepreneurship programs means thinly spread resources and duplication of effort
- Insufficiency of graduates' soft skills, in addition to technical skills, hinders business innovation
- Against a history of limited engagement, substantial scope to activate meaningful public-private partnerships
- Pillar priorities highlighted in the National STI Policy miss an essential element: the <u>culture</u> of innovation

The four-pillar structure provided a framework for analysis that maintains consistency with the policy. However, many of the review findings and trends highlighted in the following sections do not fall neatly within these four pillars. Rather, they cut across two or more pillars, such as between Knowledge Creation and Knowledge Transfer (e.g., transferring research results to industry), or Knowledge Acquisition and Innovation Culture (e.g., enhancing the soft skills of technically trained professionals such that they might boost the innovative activities of firms). For the analysis, the reviewers present cross-cutting findings and trends in only one pillar to minimize repetition.

As noted above, the STI Policy neither includes baseline data against which to compare change, nor targets to gauge what success might look like. As such, the review team relied heavily on impressions from stakeholders representing key STI sectors and institutions to understand STI Policy achievements and challenges. The analysis therefore represents key findings and trends culled from stakeholder interviews, surveys, and secondary research. The indicator dashboard, presented after the pillar findings, was designed to provoke thinking and dialogue on a notional set of indicators and targets that an M&E framework on STI might include. The reviewers strongly urge that immediate steps be taken to migrate from such notional indicators to ones that Rwandan stakeholders agree to use as benchmarks going forward.

A final section presents the review team's recommendations for reform in three areas: the STI Policy document, STI governance, and STI Policy implementation. These

recommendations follow in brief. More detailed discussion of the recommendations can be found on page 53.

Recommendations Regarding Revisions to STI Policy
- Streamline policy priorities to improve coherence and reduce duplication
- Focus on STI functions required for change, not institutional mechanisms

Recommendations Regarding STI Governance
- Create an STI Policy implementation strategy including baselines of STI investment / achievement and clear targets for progress
- Support STI priority distillation from key sectors
- Maintain institutional consistency as a way to build momentum for STI
- Orient STI institutions (e.g., DSTR, NCST) to cultivate innovation systems functions that fall outside of traditional mandates

Recommendations Regarding STI Policy Implementation
- Remove administrative barriers to Knowledge Creation
- Minimize thinning of resources across multiple innovation support programs and institutional arrangements
- Implement community-focused STI programs, not "unfunded mandates" for community engagement

Photo: Farmers near Butare, Rwanda; Credit: Global Knowledge Initiative

"The application of science and technology is fundamental and indeed, indispensible in the social and economic transformation of our countries."

-- His Excellency Paul Kagame, President of Rwanda in the 2005 Science, Technology, and Innovation Policy

Introduction & Background on STI Policy in Rwanda

Why science, technology, and innovation for Rwanda's development?

In the Preface to Rwanda's National Science, Technology and Innovation Policy His Excellency Paul Kagame writes:

> *The application of science and technology is fundamental and indeed, indispensible in the social and economic transformation of our countries. Productive capacities in modern economies are not based merely on capital, land, and labour. They are also dependent on scientific knowledge and sustained technological advances.*

Recognizing STI's transformative power but acknowledging the underutilization of these tools in the Rwandan context, he calls upon Rwandans to redouble their efforts toward harnessing STI for development: "Scientific knowledge is under-utilised generally, while our knowledge centres, which were never strong in the first place, have been in decline over the past several decades" (UNU-IAS & MINISTR, 2006).

Guiding the country's efforts toward strengthening STI capacity, two policy instruments are central. First, Rwanda's blueprint for development, Vision 2020, underscores the crucial role that science and technology play in securing the country's development aspirations. Second, the 2005 STI Policy itself offers an "ambitious but actionable plan, for the strengthening of science and technology across all sectors of our economy" (UNU-IAS & MINISTR, 2006). Organized across four pillars that correspond with the knowledge-to-innovation cycle, the STI Policy explicitly points to the role STI can play in Rwanda's key industrial sectors ranging from agriculture and biotechnology to water and transport. The Policy proposes a number of changes aimed at boosting performance within and across the pillars in the form of: (1) public sector reforms and adjustments; (2) science and technology (S&T) outreach; and, (3) incentives for implementation.

Both Vision 2020 and the STI Policy assert that in the absence of STI, achievement of Rwanda's chief development aspirations (featured in the Figure to the right) will prove difficult. Science, technology, and innovation in the form of scientific and technical know-how, trained doctors and health workers, and facilities for research and training are vital for ushering in a knowledge economy, increasing gross domestic product (GDP) per capita, and boosting life expectancy. Indeed, the

Figure 1: Schematic of Vision 2020 objectives moving downward from its overarching goal of middle-income country status by 2020.

everyday lives of Rwandans stand to benefit from the contribution of STI, be it in the classroom, the job site, or the home. Examining the degree to which the policy emboldens all Rwandans—children and teachers, technicians, entrepreneurs, researchers, etc.—to achieve more productive lives orients the methodological approach used to measure the policy's impact.

Research methodology and approach

In April 2013 GKI conferred with MINEDUC's DSTR to inform the choice of methodological approach for the review. At issue was how best to balance qualitative and quantitive approaches to data gathering, and what framework to use in analyzing that information. In the absense of baseline STI data and clear targets for progress, the review team required an analytical framework that allowed the integration of available quantitative data with qualitative insights from STI stakeholders. The review team developed multiple options for analysis, each with a unique orientation to the policy and its many recommendations. Options included the following analytic orientations:
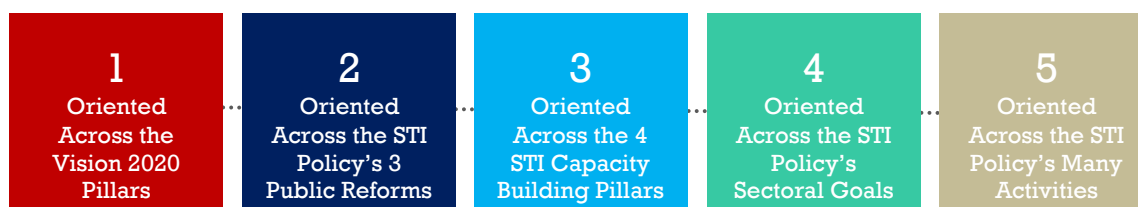
Figure 2: Possible orientations to the STI Policy review

Based on DSTR's assessment of these options, the evaluation team proposed an integrated approach that would allow for an exploration of multiple dimensions simultaneously. The first dimension is composed of the four STI Capacity Building Pillars — Knowledge Acquisition, Knowledge Creation, Knowledge Transfer and Cultivating an Innovation Culture. The second dimension is oriented along the proposed public reform mechanisms. The STI policy speaks directly to three types of public reform mechanisms, as highlighted in the figure to the right. Within this matrix structure, impressions from key stakeholders within the agriculture, water, ICT, transport, environment, and other sectors would be used to ground the analysis in sectoral insights.
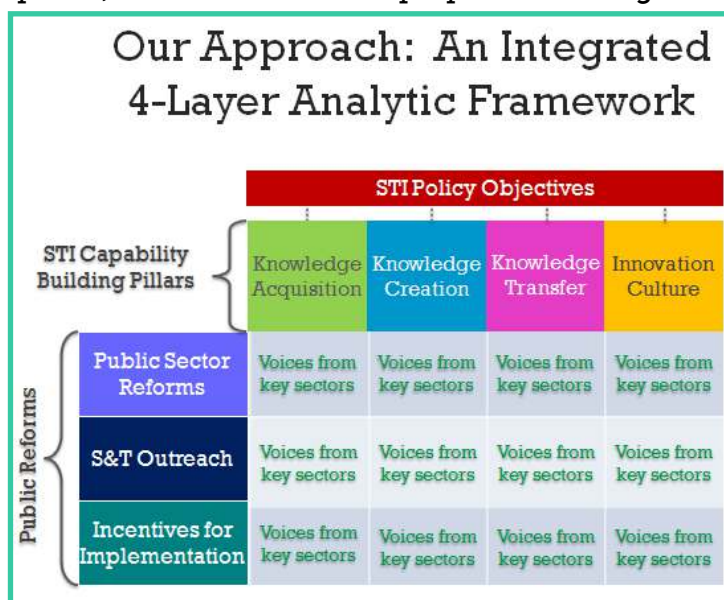
Figure 3: An integrated, 4-layer analytical framework for STI Policy review

The review team presented the integrated analytic framework at a May 2013 Workshop, presided over by the Minister of Education, the Acting Director General of DSTR, and the Director General of the newly established National Science and Technology Commission. Reflecting upon the proposed evaluation framework, the 100+ STI stakeholders in attendance concluded that the framework was sound and encouraged its application.

To begin the review process, stakeholders contributed answers to two questions that were then assembled in real-time at the May 2013 Workshop. These questions were designed to illustrate the distribution of stakeholder views expressed at the workshop:

Facilitators clustered the responses elicited according to the four STI Capacity Building Pillars, which offered a first impression of stakeholders' perceptions on the policy's greatest impact to date and forthcoming opportunities to seize. Annex VI highlights the responses, noting points of convergence between respondents.

Following the workshop, the evaluation commenced in earnest, with the research team sourcing data through multiple channels. Chiefly, a four-person team led by Sara Farley and composed of Amanda Rose, Andrew Gerard, and Jean Paul Safari collected first-person impressions and insights on STI using the integrated framework discussed above. The review team conducted over 30 interviews with stakeholders including representatives of government, private sector, professional societies, and universities. The result: more than 200 pages of unique insights, quotes, and data points. In many cases, the information gathered is particularly valuable given its paucity in other reports to date. The interview protocol used by analysts may be found in Annex I.

Figure 4: Questions reviewers considered in conducting the National STI Policy review

An original survey designed by the team constituted a second evaluation tool. Targeting a diverse cross-cut of STI stakeholders, many of whom tend to be neglected in formal treatments of STI's impact on society, the survey presented 13 questions. One hundred and seventy eight people completed the survey administered by the review team, including miners, construction workers, security workers, teachers, and workers active in food processing. Survey results support many of the findings elicited through interviews. Both the survey protocol and the analysis of results may be found in Annex II.

Third, the team performed a thought experiment aimed at filling in the data gaps exposed by a dearth of an implementation plan, baseline data, and quantitative targets. Dubbed the "STI Indicator Dashboard," this tool offers a preliminary answer to the question, "Had quantitative indicators been assigned to the policy in 2005, what would the data reveal? Progress or stagnation?" The section entitled "Notional STI Policy Indicators" elaborates upon this experiment in indicator design and data tracking. Less a definitive analysis of the country's progress toward policy implementation to date, the Indicator Dashboard provokes questions that can inform selection of optimal indicators and performance targets to fuel M&E in the future.

Elements of the Evaluation Report

The resulting evaluation report presents a synthesis of the research team's findings. The paper *does not* offer a comprehensive analysis of the STI system in Rwanda but rather a

provocation informed by critical stakeholders. In terms of organization, the paper opens with a background on STI governance in Rwanda to date. Complex and shifting, the institutional governance structures within STI bear greatly on the conditions for policy implementation. Supported by a timeline of key STI governance events (see Annex V), six trends characterize the storyline that underpins the last eight years.

STI governance, of course, does not occur in a vacuum. The manner in which STI policy formulation and implementation translate into progress for society bears on the broader context—macroeconomic, infrastructural, sociological, etc. These contextual influences are consolidated into a list of 11 "drivers." These drivers correspond with targets for government reform. For example, an increase to the use of ICTs and an ambition to reach 11.5% economic growth both influence how society perceives the contribution of STI to development.

Eight "Questions on the Horizon" follow the drivers. These questions represent significant uncertainties that bear on the future of STI in Rwanda. Depending upon how we react to them, they may constitute threats or opportunities. For example, how will the One University policy change Rwandan higher education institutions' relevance and quality? What are the implications of greater regionalization through the East Africa Community (EAC)? These "wild cards" underscore the fact that the Rwandan STI system must be examined within the context of broader questions that as of yet lack clear answers.

The core of the report follows. Organized around the four policy pillars, a chapter is devoted to each. Contents within each chapter are structured into three categories: (1) policy features not recognized by respondents, (2) status of policy implementation as derived from respondent feedback, and (3) respondent feedback on policy features not called for explicitly within the language of the policy itself. Although the evaluation report upholds the four-policy pillar structure, it suffers from a crucial weakness embedded in the policy itself. Namely, many of the specific activities called for within the policy do not neatly fit into any single dimension of the four-pillar structure. For example, efforts to address the need to boost practical training of STI students bear both on Knowledge Acquisition and Knowledge Transfer. To maintain consistency with the policy, in such instances the report attributes cross-cutting programs to the pillar in which it was featured in the policy itself. However, the broader influence of these initiatives should not be relegated to placement in a single policy pillar.

Finally, recommendations from the review team conclude the report. Three types of recommendations are presented: those pertinent to the STI Policy document, STI governance, and STI policy implementation. Annex VII provides an overview of additional priorities for action as identified by participants of the June 2013 workshop.

Background on Rwanda's science, technology, and innovation agenda

This section explores the marquee events in Rwanda's recent STI history into two sections: an overview of STI governance 2005-2013, and a snapshot of the contextual drivers that shape STI in 2013.

STI Governance background: Momentum and Flux, 2005-2013

Significant shifts in the governance of STI characterize the eight years since the approval of the STI Policy. One of the most important changes early in the policy's existence was the prominence brought to STI through the establishment of the Ministry of Science, Technology

and Scientific Research (MINISTR) in 2006. This Ministry, led by the Prof. Romain Murenzi, sparked a period of high visibility for STI. During the three years that Prof. Murenzi led MINISTR, it published a number of reports and strategies aimed at propelling STI forward, including some international publications such as *Building Science, Technology, and Innovation Capacity in Rwanda*, a collaborative effort with the World Bank. During this period the Ministry worked to draft a legal framework to establish both a law governing STI in Rwanda and a National Commission for Science, Technology and Innovation as prioritized in the National STI Policy. In mid-2009, though, governance of STI changed in important ways.

In 2009 the government transferred the mandate for Science, Technology and Research from MINISTR to MINEDUC. Previously, MINISTR had overseen both scientific efforts and ICT expansion. The ICT mandate was separated from Science, Technology, and Research and temporarily remained in the Office of the President. Many STI Policy Review interviewees believed that the STI Policy's implementation efforts slowed at that time. DSTR respondents however, noted that housing a Directorate within the Ministry of Education with the mandate for STI capacity building was beneficial, allowing them to directly engage with capacity building programs within the Education sector.

From 2009 to 2013, MINEDUC's Directorate of Science, Technology and Research (DSTR) managed the implementation of the STI Policy. Early in its stewardship of the policy, it attempted to organize implementation through four units: STI in Research and Education, STI Policy, STI in Society, and STI Partnerships. Rwanda's Cabinet approved two of these units—STI in Research and Education, and STI Policy. Thus, those two units guided many DSTR activities. The wide scope of activities called for in the policy necessitated significant resources—human, financial, and institutional. The lack of additional units and staff meant that DSTR faced resource constraints that posed a challenge to implementing some activities called for in the STI Policy.

In 2011, MINEDUC reorganized again, modifying the structure of units. The STI in Research and Education Unit became the Research and Development (R&D) Unit, and the STI Policy Unit was replaced with a Science Unit. MINEDUC also added a unit for ICT in Education. This new configuration put responsibility for the STI Policy's Knowledge Acquisition pillar on the Science unit, and the Knowledge Creation, Knowledge Transfer, and Innovation Culture pillars on the R&D unit. Despite at times facing challenges in allocating resources for these priority areas, during MINEDUC's management of STI Policy implementation, there have been successes. These include the development of funding mechanisms for research and for innovation-based activities, the expansion of STI training in schools, growth of science as a discipline within the university community, and other programs.

Throughout this period, DSTR continued communicating with Parliament to develop a National Commission for Science, Technology, and Innovation. In 2012 the Prime Minister's office announced the establishment of a National Commission of Science and Technology (NCST) separate from MINEDUC. MINEDUC and NCST are in the process of dividing roles such that they can effectively and efficiently continue STI Policy implementation and support system-wide transformation in pursuit of Vision 2020 goals.

Themes in STI Governance

An "STI Governance Timeline" in Annex V offers a brief history of STI governance in Rwanda. Summarized below, the timeline and interview responses reveal six trends that weave throughout the last nine years in which meaningful programmatic achievements occurred, despite any inconsistency in the institutions and personalities leading them.

1. **Structural flux in STI governance:** Since the STI Policy's approval in 2005, the entities governing its implementation have often shifted roles or responsibilities. As noted, MINISTR existed for a relatively short time, after which responsibilities were moved to MINEDUC and MYICT. Within MINEDUC, responsibilities and roles were again changed substantially in 2011. The rise of implementation boards that serve line Ministries (e.g., Rwanda Education Board, etc.) has precipitated further changes in responsibility, especially for the STI in education portfolio. At the level of STI Policy implementation programs, changes in the overall policy landscape have at times posed challenges to STI implementers' ability to plan ahead. Three examples illustrate this point. First, MINECOFIN's decision to halt internal government fund transfers meant that MINEDUC had to change the way it supported university-level research, and in doing so fulfill the policy's Knowledge Creation pillar (Ministry of Local Government, 2012). Second, the establishment of NCST, though called for by the STI policy, portends further flux as the advisory and implementation functions for STI must be reconfigured. Finally, with the One University system coming into effect, implications for coordination and governance of scientific training and research will soon become apparent.

2. **Programmatic achievement despite ad hoc implementation**: Despite the initial lack of an implementation strategy and multiple reorganizations of STI governance, DSTR and others tasked with implementing the STI Policy have made positive strides. Interviews and survey data presented in the subsequent section of this report acknowledge advances despite a changing cast of institutions and individuals undertaking them. Examples include expansion of laboratories and science kits in schools, grants for research, the newly established Knowledge Transfer Partnership (KTP) and Rwanda Innovation Endowment Fund (RIEF), and other initiatives. Based on data elicited through the evaluation, it is difficult to determine why certain programs called for within the policy occurred but others did not. For example, few if any programs occurred in the Innovation Culture pillar prior to the launch of RIEF, while many successful activities took place under the Knowledge Acquisition pillar. Some of the "successes" most commonly pointed to by STI stakeholders, specifically expansion of ICTs and TVET programs, are not actually under the purview of the entities governing STI, further complicating the analysis of STI governance.

3. **Change driven by personalities:** During specific segments of the 2005-2013 STI governance timeline, Rwanda witnessed successful governance driven by especially effective leaders. Specifically, in the years directly after the publication of the STI Policy, Rwanda's STI system experienced visibility and fast consolidation driven by key personalities. During less successful periods, however, the reliance on personality-driven leadership posed a risk of partial policy implementation and initiatives losing political support. Multiple STI stakeholders mentioned in interviews that they believe the success of universities such as the Kigali Institute of Science and Technology (KIST) and the National University of Rwanda (NUR) (now University of Rwanda) also ebb and flow based on the passion and leadership of their Rectors. While this is true to some extent in every country, in countries with scarce STI resources, it is important that governance structures can outlast charismatic or especially effective leaders, thereby building off of their successes.

4. **Additional resources needed to support implementation**: The STI Policy is broad and ambitious; effective implementation requires sufficient financial support. As an entity charged with implementing the policy, DSTR has historically faced human resource challenges (Global Knowledge Initiative, 2013). Along with frequently changing staff roles, unit reorganization has not always been coupled with sufficient increases in

staffing. In founding NCST, it is important that additional resources flow toward STI support, rather than spreading the same volume of resources across a greater number of administrative bodies.

5. **Additional outreach to civil society, industry, and other key stakeholders needed**: A dearth of clear mechanisms exists for universities or the private sector to feed back ideas into STI governance structures. A substantial proportion of interviewees who work in STI-related fields outside of government had either never heard of the STI Policy, or did not know what it contained. In fact, interview respondents from other STI-related *government* entities noted that the STI Policy did not affect their work. One respondent from industry stated that he believed the policy to be an "academic exercise" that did not bear on his company's work (Global Knowledge Initiative, 2013). Additional outreach is required to show the relevance of the STI Policy to its target stakeholders.

6. **STI governance structure requires strengthening:** Before 2012, there were challenges with STI Policy implementation, as has been outlined; the introduction of the NCST in late 2012 signals additional need to strengthen the STI governance structure. The law governing NCST has been approved by Parliament. The relationship between DSTR and other STI-related institutions will be clarified based on the law governing NCST, to ensure that there is no duplication of or gaps in responsibility, and that each institution has a clear mandate. To support this objective, MINEDUC and NCST have laid plans to formulate strategies both for the STI Policy's implementation and, separately, the institutional organization of NCST. Clarifying the respective roles and collaborative responsibilities of NCST, DSTR, and other STI-related institutions will greatly enhance implementation of the STI Policy.

Understanding STI in the Broader Context

The context against which STI policies promote achievement of Rwanda's development goals or languish as unused assets merits brief exploration. On all counts, Rwanda boasts a fast-moving economy, one in which the thirst for job-relevant skills, productivity-enhancing tools, and wealth-creating ideas seems insatiable. How Rwanda's future unfolds prompts a question central to this evaluation: how can STI help usher in economic, social, environmental progress through 2020 and beyond? And, how does the policy serve as fuel to ensure Rwanda reaches its goals?

Two segments follow, both designed to outline the broad contours that shape the STI policy implementation environment: Drivers and Questions on the Horizon. The Drivers represent trends so significant that hard targets have been articulated and tracked. The Questions on the Horizon represent uncertainties that bear on the future of STI in Rwanda, and thus the degree of success or lack thereof of policy reforms. The findings presented within the STI Capacity Pillars that follow should be read within the broader context of both sets of factors.

Key Drivers

Several key drivers shape Rwanda's STI system. Below, 11 drivers follow together with the target against which each driver is measured. Derived from Rwanda's chief development documents—EDPRS II and Vision 2020—the drivers shape the broad outline of reforms in Rwanda. One may think of these drivers as the powerful currents guiding the allocation of resources—institutional, financial, political, human—throughout the system. Developments in STI are both influenced by and influential within the context of these drivers.

Create more private sector jobs
Target: 200,000 new jobs created per year

Under-performing	On target	Better than target
●	○	○

Expand access to a revitalized TVET system
Target: Create a sufficient cohort of mid-level skilled TVET graduates who are employable

Under-performing	On target	Better than target	N/A
○	○	○	●

Grow the economy
Target: 8.1% annual economic growth rate (recently retargeted to 11.5%)

Under-performing	On target	Better than target
○	○	●

Shift from agriculture-based to services economy
Target: Agricultural employment down to 50% by 2020

Under-performing	On target	Better than target
○	●	○

Expand access to ICTs
Target: ICT penetration rate of at least 40% in 2012

Under-performing	On target	Better than target
○	○	●

Cultivate youth as job creators as opposed to job seekers
Target: Implement policies to support entrepreneurship

Under-performing	On target	Better than target
○	●	○

Support opportunities for rural development
Target: Various targets in EDPRS II—no data available

Under-performing	On target	Better than target	N/A
○	○	○	●

Decrease income inequality
Target: Reduce Gini coefficient to 0.40 in 2010 and 0.35 by 2020

Under-performing	On target	Better than target
●	○	○

Orient universities toward labor market needs
Target: More than 90% of employers satisfied with university graduates by 2015

Under-performing	On target	Better than target	N/A
○	○	○	●

Coordinate donor support
Target: Implement a Sector Wide Approaches (SWAp) for key sectors

Under-performing	On target	Better than target
○	●	○

Prioritize District-level service provision
Target: More districts achieving 80% of their service delivery and sustainable local development targets

Under-performing	On target	Better than target
●	○	○

Questions on the Horizon

Key drivers of Rwanda's STI system must be considered against a dynamic and changing backdrop. While some indicators suggest a high probability of continued progress, others are open to interpretation. These Questions on the Horizon introduce major uncertainties into any future outlook on Rwanda's STI system. Though many more than eight questions exist, those presented below constitute the most crucial but variable factors that rose to the top in interviews, desk research, and stakeholder convenings.

Demographic Shifts
85% of Rwanda's population is under 35 years of age. What the "youth dividend" means for Vision 2020 achievement hinges upon Rwandans' access to industrially relevant education and training.

One University
The integration of Rwanda's public universities into a single institution poses a number of questions about comparative specialization, resource allocation, governance, and optimizing the industry-academia interface.

Funds to Universities
The manner in which universities can legally receive government funds changed in 2012. What this means for the sustainability of research, particularly grant-funded research, is unclear.

Personnel Changes in STI
As key champions within the upper echelons of government come and go, STI's prominence in policy and governance fluctuates. Changing personalities equal changing priorities.

Looking forward, how how will STI usher in economic, social, and environmental progress through 2020 and beyond?

Birth of the NCST
How well the NCST complements existing STI institutions will determine the degree to which it is construed as successful or not with respect to Vision 2020 achievement.

Regionalization Through EAC
Policy priorities include enhanced labor market mobility and increased trade. How do these ambitions assert new pressures on the STI capacities of Rwanda?

Quickly Growing Private Sector
Alongside ambitious government targets for job creation, Rwanda's small private sector is growing. With a changing labor market comes a change to the skills required of job seekers.

STI's Role in EDPRS II
An integral part of EDPRS I, STI has less emphasis in EDPRS II. How that will shape the STI Policy implementation environment remains to be seen.

Photo: Riviera Secondary School, Kigali; Credit: Global Knowledge Initiative

"The big achievement [of the National STI Policy] has been the recognition of STI as an enabler of development."

-- Fred Mugisha, Director of Policy, Research, and Planning, The National Council for Higher Education

Pillar One: Knowledge Acquisition

Knowledge Acquisition represents a focal point of the STI Policy. Objectives within the Knowledge Acquisition pillar include cultivating and retaining interest in S&T; and training competent artisans, high-level technicians, and other S&T professionals to give high quality support to the development needs of Rwanda. Annex IV provides an overview of other STI Policy priorities and proposed reforms pertinent to Knowledge Acquisition.

Policy features not recognized by respondents

A few notable achievements indicate direct gains made since the approval of the STI Policy, though it is striking that only staff managing these programs identified these as gains. They largely went unnoted by broader respondents. According to DSTR, Rwanda now has 87 science secondary schools of excellence across the country's 30 districts, and the government has stated a goal of creating 4 science secondary schools of excellence per district by 2016 (Global Knowledge Initiative, 2013). These schools include public boarding schools with a science focus, and are priorities for implementation of lab infrastructure and equipment. As of 2011, nearly 11,000 secondary school teachers used science kits to support instruction (JICA, 2011). All of these gains occurred since the policy was enacted in 2005.

> # 59%
> of individuals surveyed "agree/strongly agree" that the math and science classes their children are taking will prepare them to be successful.

Additional strides include the One Laptop per Child program, which reached 50% coverage, though DSTR acknowledged that challenges of electricity supply and sustainability have dampened its overall impact (Global Knowledge Initiative, 2013). Additionally, a number of STI outreach programs were initiated in the last few years aimed directly at boosting awareness of and excitement for STI among students (Ibid). These include science exhibitions in schools (in partnership with the French embassy); science competitions that award student excellence on practical and theoretical aspects of STI (in partnership with the Korean Government); and World Science Day, which includes country-wide demonstrations and workshops on STI for the public (in partnership with UNESCO) (Ibid). Despite these gains, the coverage and the frequency of the outreach efforts are too minimal to consider these initiatives as major contributors of Rwandans' increased interest in STI.

Status of policy implementation derived from respondent feedback

Key Knowledge Acquisition trends in Rwanda:

- *Rwanda characterized by high-level commitment to STI-based education, as illustrated by progressive scholarship scheme for STI-based studies*
- *Women and girls achieving increased access to STI-based education and careers*
- *Lack of practical exposure through STI-based education hinders relevance and employability of graduates*
- *Rwanda not yet able to meet demands for engineers and PhD-level STI professionals, though numbers are increasing*

Rwanda characterized by high-level commitment to STI-based education, as illustrated by progressive scholarship scheme for STI-based studies

The high-level of commitment to STI-based education in Rwanda represents one of the greatest achievements in Knowledge Acquisition and for the STI Policy broadly. As one respondent from Rwanda's Higher Education Commission (HEC) stated: "The big achievement [of the STI Policy] has been the recognition of STI as an enabler of development" (Global Knowledge Initiative, 2013). For example, now when the National Council for Higher Education gives out student loans, 70% award students in STI-related courses. Additionally, a number of respondents pointed to the Presidential Scholars Program as a success in terms of boosting student interest in and pursuit of STI-related degrees at university-level (Ibid.).

While funding has proven a challenge, stakeholders expressed satisfaction that the early years of such programs achieved sufficient sensitization for STI among students. Indeed, the country's top three public universities (NUR, KIE, KIST) experienced significant growth in the number of students pursuing STI-related courses since the enactment of STI policy: in 2012, 42.31% of students in these three universities were pursuing STI-related studies, compared to 35.75% in 2005 (NUR, 2013; KIST, 2013; KIE, 2013).[1]

Women and girls achieving increased access to STI-based education and careers, though still not at level desired

48.7%

of upper secondary science students were girls in 2012 (MINEDUC, 2012)
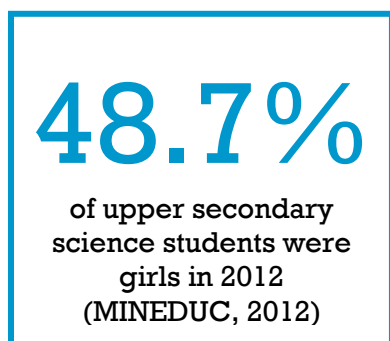
As called for in the STI Policy, women and girls continue to gain increasing access to STI-based education and careers in Rwanda. The increasingly gender-sensitive policy environment no doubt contributed to this improvement: the Girls Education Policy published in 2008 highlights increasing girls studying science and technology as a major priority. The African Development Bank also sponsored a two-year program aimed at enrolling 200 girls in tertiary institutions by the end of 2011, with half of those pursuing STI-based studies (Kwizera, 2010). As a result of these efforts, Rwanda has almost reached gender parity in students studying science in upper secondary school, with girls accounting for 48.7% of those studying science (MINEDUC, 2012).

Despite gains, many leaders in STI believe there is still work to be done in accelerating female access to STI-based education and career paths in Rwanda. Some believe teachers and others must find ways to boost the confidence of girls in pursuing these options. For example, a representative of the Kigali Health Institute stated, "I believe girls are hesitating to take science classes…Once they are pushed they are doing a great job. We need to show them that they are able" (Global Knowledge Initiative, 2013). Others are actively removing structural barriers to women and girls' access to STI. For example, KIST is raising money to construct a women's hostel on campus, which they hope will provide additional incentives for women to study math, physics, and other disciplines in which females are under-

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[1] One reason for the growth in the proportion of students in STI-related subjects is that in 2008, KIST included management and business training. These programs moved to the School of Finance and Business, though, so as of 2012 100% of KIST's students studied STI-related subjects. That said, the proportion of students at NUR studying STI-related subjects rose from 31% to 42%, and although KIE saw a slight drop in the proportion of students studying STI-related subjects, NUR's increases more than makes up for this drop.

represented. Currently, the university's hostels can only accommodate 10% of students, deterring women pursuing higher education (Ibid.).

Lack of practical exposure through STI-based education hinders relevance and employability of graduates

Respondents almost ubiquitously noted the lack of practical, hands-on training for STI-based students as a major bottleneck to fully realizing the aspirations of the STI Policy. According to an executive at ManuMetal, one of the country's leading engineering and fabrication shops, the lack of practical skills of graduates constitutes a constraint for their business: "In terms of the engineers we hire, they are book worms. They know their theory, but they have no exposure to hands on practice" (Global Knowledge Initiative, 2013). There are a number of factors at play that limit the amount of practical exposure students receive during secondary and tertiary education. Challenges include limited equipment and infrastructure for hands-on instruction, as well as the lack of teachers qualified to parlay knowledge through practical activities. As one respondent from the Ministry of Trade and Industry noted: We have a "mismatch between skill providers and those that need them. We are running very fast but we lag behind in terms of the supply of knowledge and people who need it and where we want to be"(Ibid.).

The establishment and rapid expansion of the TVET (Technical and Vocational Education and Training) system garnered acknowledgement by several respondents as an important accomplishment that has the potential to turn the tide against theoretical STI education in Rwanda. According to a respondent from the Rwandan Development Board, there has been a "gradual transition from theoretical education systems toward technically-oriented education systems through the establishment of TVETs" (Global Knowledge Initiative, 2013). One compelling example of the emphasis on technical training is the national budget for TVET, which grew

36.5%
of individuals surveyed have received training from associations such as cooperatives (GKI, 2013)

from 2.126 billion RF in 2008 to 16.442 billion RF in 2012-2013 (MINECOFIN, 2008; MINECOFIN, 2012). Additionally, multiple interviewees noted the government's plan to enroll 60% of all secondary students in the TVET system by 2017 (New Times, n.d.). For one respondent from KIST, this change represents a welcome reform: "The structure of human resources is supposed to be a pyramid…Now we have an upside down pyramid…All of these [university] graduates and no technicians! We have many people now coming to university. They have papers, but no hands-on [experience]" (Global Knowledge Initiative, 2013). Beyond improving outlets for technical training in Rwanda, efforts also are underway to improve the industrial attachment opportunities for students; more can be found on this issue in Pillar III: Knowledge Transfer.

Rwanda not yet able to meet demands for engineers and PhD-level STI professionals, through numbers are increasing

The call for a more robust cadre of skilled technicians comes alongside a continued effort to grow the number of highly-qualified engineers and PhD researchers available in Rwanda. In terms of PhD holders, Rwanda only began offering post-graduate degrees in 2003. As of 2012, the National University of Rwanda—one of the country's leading technical institutions—had graduated 2 PhDs (NUR, 2012). Most of the PhD holders in Rwanda are trained outside of the country, and the number of those being attracted back to Rwanda though low has grown. That said, respondents consistently allege that the demand for

highly skilled professionals outpaces the supply (Global Knowledge Initiative, 2013). An executive at the Rwanda Agriculture Board (RAB) acknowledged the Directorate for R&D only employs 8 PhD scientists despite the fact they undertake research on over 40 commodities (Ibid.). Other university respondents noted similar deficits. For example, as of 2010, across the Rwandan university system, only 15.6% of academic staff hold PhDs. Forty-eight percent possess master's degrees, and 34.4% completed only bachelor's studies; the rest have diplomas (Sindayigaya, 2010). More recent figures for training level of academic staff were not available for comparison.

15.6%

of academic staff working in Rwandan universities are PhD holders, as of 2010 (Sindayigaya)

For engineering specifically, a leader at the Private Sector Federation stated, "Until a year ago, you could count the qualified engineers [in Rwanda] on your hand" (Global Knowledge Initiative, 2013). One self-employed engineer noted he sometimes works for five or six companies at a time because demand is so great (Ibid.). The tide is shifting now, as exemplified by the newly inaugurated Engineers Institute of Rwanda, a professional association for Rwandan engineers. The Institute had 140 members at its start, though only 41 engineers met the requirements to work as certified members of the Institute (Ntagungira, 2013).

Questions loom regarding the best ways to attract talent into these highly competitive, rigorous fields. One respondent from RBS suggested that Rwanda be more proactive in recruiting back students that go abroad to study (The Global Knowledge Initiative, 2013). He noted that requirements for in-person interviews and other barriers make it difficult for Rwandans who are abroad to be incorporated back into the Rwandan economy. Additionally, other respondents stated their hope that the One University process will streamline the resources and support necessary to produce high-quality engineers and PhD scientists, noting this will further boost the country's capacity in these areas (Ibid.).

Respondent feedback on Pillar features not included in Policy

One self-employed engineer recommended developing engineering training centers such that professional engineers can access continuing education courses (Global Knowledge Initiative, 2013). Such training is paramount in the engineering field because "every day some new development comes" and currently there is no streamlined way to access professional courses in Rwanda (Ibid). Additionally, other respondents pointed to the rural-urban divide as a challenge in promoting Knowledge Acquisition in the country (Ibid.). In some settings, schools have computers but lack the electricity to run them, so students who progress into higher education enter university lagging behind in terms of computer proficiency and other areas. As currently written, the STI Policy does not provide any direction for addressing regional differences in STI-based education and training programs.

Photo: Specialty coffee cupping lab that analyzes coffee quality;
Credit: Global Knowledge Initiative

"We need the public to think about research. Many people don't know this is a big and important area of development."

-- Odette Mukabayire, Former Director General of the National Reference Library

Pillar Two: Knowledge Creation

Knowledge Creation, the second pillar of the STI Policy, includes priorities such as establishing a National Commission for STI; investing in the development of international research partnerships; and equipping research institutions. Training high-caliber scientists, engineers, and other STI professionals constitutes a priority for the Knowledge Creation pillar, but it is featured as a part of Pillar I (Knowledge Acquisition) for the purposes of this review. Additionally, while the policy called for the establishment of a National Commission for STI within the Knowledge Creation pillar, analysis of this priority may be found within the "Background on Rwanda's STI Agenda" section given the implications for STI governance. Annex IV provides an overview of other policy priorities and proposed reforms pertinent to Knowledge Creation as stated in the STI Policy.

Policy features not recognized by respondents

The Knowledge Creation pillar highlights as a priority "creat[ing] an effective intellectual property management framework" as well as a "legal framework to protect intellectual property rights." In 2009, the Government of Rwanda released the National Intellectual Property (IP) Policy, with support from the World Intellectual Property Office (WIPO), the UN Commission on Trade and Development (UNCTAD) and International Center for Trade and Sustainable Development (ICTSD). The Office of the Registrar General, which supports the implementation of the IP Policy, was created in 2008 as part of the Rwanda Development Board's Investment Promotion and Implementation Division. Despite these tangible gains (and their relation to the STI policy framework), none of the respondents commented on intellectual property either as a bottleneck to Knowledge Creation or a success within the context of this pillar.

The STI Policy also calls for the creation of a National Research Fund, which will avail a proposed 0.5% of GDP for research investments. While one policy review workshop participant noted the creation of the National Research Fund as an accomplishment, the review team confirmed this reform has not yet been implemented. The funding mechanism most similar to the National Research Fund, according to MINEDUC, is the Rwanda Innovation Endowment Fund, discussed in the "Innovation Culture" chapter (Global Knowledge Initiative, 2013).

Status of policy implementation derived from respondent feedback

Key Knowledge Creation trends within Rwanda:
- *Agricultural research illuminates how Knowledge Creation can accelerate sectoral development*
- *Sub-optimal incentives and metrics for research impede research productivity*
- *Mismatch between research outputs and market needs hinders potential impact*
- *Forthcoming research policy, if well designed, bodes well for clarifying the current ambiguity on research*

Agricultural research illuminates how Knowledge Creation can accelerate sectoral development

In conducting the policy review, few sectors boasted as many tangible research outputs as the agriculture sector. Led by efforts of RAB, Rwanda has successfully generated new knowledge for drought resistant varieties, flood resistant varieties, and nutrient-enriched varieties. In two particular successes, RAB created a Vitamin A-enriched cassava variety and orange-flesh sweet potatoes (Global Knowledge Initiative, 2013). As evidence of the

translation of knowledge to value for society, farming associations have partnered with private sector to create sweet potato biscuits that are bio-fortified with Vitamin A. Agricultural research also catalyzed innovation in banana hull processing and silkworm cultivation, which are now benefiting Rwandan farming cooperatives and individual farmers (Ibid.). A recent entrant to the Rwandan innovation system, the Rwanda National Gene Bank began conserving seeds and other genetic materials with the aim of preserving the country's biodiversity in 2013 (Ishimwe, 2013). The gene bank, if well managed and resourced, has the potential to propel agricultural research outputs in Rwanda. These achievements, along with other advances made, represent important strides in agricultural research over the last 8 years.

In terms of the policy review, it is unclear whether the STI Policy contributed directly (or indirectly) to these achievements in the agriculture sector. Certainly, the Policy highlights agriculture as a priority sector, and provides specific language to that effect. Additionally, DSTR, which is the responsible implementing agent of the STI Policy, supported both the banana processing and the silkworm projects listed above. A representative from RAB acknowledged that the policy was instrumental in "creat[ing] a conducive environment in which to carry out scientific research and innovations," but also recognizes that the Directorate of R&D "doesn't look at the STI policy specifically" in designing and implementing research programs that are also addressed under the policies of the Ministry of Agriculture (The Global Knowledge Initiative, 2013).

Sub-optimal incentives and metrics for research impede research productivity

Numerous respondents pointed to the lack of *personal* (rather than institutional) incentives to conduct research as an impediment to Knowledge Creation. For example, one respondent noted that university faculty do not undertake research because of their heavy workloads and lack of funding available (Global Knowledge Initiative, 2013). Another from KIST stated that "research has always been hampered by red tape," creating administrative barriers for individuals who seek to engage in Knowledge Creation (Ibid.). A change in Ministry of Finance and Economic Planning (MINECOFIN) policy, for example, halted the distribution of research funds to post-doctoral fellows at the Kigali Health Institute for the last two years. The policy change (which prohibits inter-entity funding transfers) precludes MINEDUC from distributing research support to universities. Now all research funds must be distributed through individual contracts, adding another layer of administrative burden to the process. Multiple respondents did mention one positive incentive in place: the tax-exempt status of computers and research equipment (Ibid.).

Beyond limited individual incentives for research, the metrics used to quantify excellence in this area reveal further questions about how individuals are rewarded for Knowledge Creation in Rwanda. A globally recognized metric for research output, measurement of academic publications offers an easily quantifiable way to assess how much new knowledge is being created in the world, and by whom. Publication metrics are not comprehensive (e.g., these figures often do not represent articles published in local/regional journals), but they provide an indication of scientific output against which to compare countries' research activities.

> # 0.162
> number of internationally indexed articles Rwandan researchers published per 10,000 people in 2012 (Web of Science, 2013)

By global standards, Rwanda's publication rates are low, and only improving marginally. In 2005, Rwandan researchers produced 0.022 published articles per 10,000 people; In 2012, they produced 0.162 published articles per 10,000 people (Web of Science, 2013). Kenya, as a comparison, moved from .215 articles per 10,000 people in 2005 to 0.349 in 2012 (Ibid.). For respondents and the reviewers alike, these figures provoke questions. What incentives or pressures for publication does the Kenyan system offer its researchers that Rwandans do not encounter? Perhaps more importantly for both systems, how do the fruits of this knowledge creation effort translate into improvements against development goals? Given the urgent social and economic challenges facing Rwanda, quantifying research outputs in terms of questions answered, problems solved, and communities served may offer more appropriate measures of "success" than papers published.

The creation of a National Research Council, as suggested by a participant in the May 2013 policy review workshop, may offer a platform to grapple with the question of aligning incentives and metrics to achieve demonstrable gains through Knowledge Creation (Global Knowledge Initiative, 2013). Additionally, existing platforms such as the National Council for Higher Education, the NCST, and the ongoing process to create a National Research Policy (see below) may support discourse and decision-making on research outputs and incentives.

Mismatch between research outputs and needs hinders potential impact

Closely related to the above point, the research enterprise in Rwanda, however nasent, appears to be struggling to align itself to deliver the inputs for social and economic transformation as called for in Vision 2020 and the STI Policy. A number of factors complicate the alignment of research outputs with needs as expressed by the market and communities. First, respondents pointed to the lack of available in-country funding for research as an impediment to alignment (Global Knowledge Initiative, 2013). As an example, the research budget for KIST, one of the country's leading STI-based institutions, made up just over 1% of the annual university budget in 2012-13 (KIST, 2013). Universities currently receive support for salaries and facilities from the national budget, but must identify external partners for research funding (Global Knowledge Initiative, 2013). According to one respondent, "Support from government for university-based research is limited to the Ministry of Education providing scholarships to people doing PhDs," (support which has since been halted due to the discussed policy change by MINECOFIN) (Ibid.). The result of depending on donors and international partners for research funds: externally driven research agendas that do not map closely to the needs of Rwandan businesses and communities (Ibid.). Major sponsors of research in Rwanda include the Swedish International Development Cooperation Agency (SIDA), the UK Department of International Development, and United States Agency for International Development (USAID). This structure for research funding creates a paradox for the research community: while grateful for the donor support that is invested in resesarch, there is a strong sense that, according to a lecturer at NUR, "if we only do research for donors, it will not fill national needs" (Ibid.).

> # 1.16%
> percent of KIST budget allocated to research in 2012-2013, up from 0.33% in 2008
> (KIST, 2013)

Additionally, respondents pointed to another challenge in aligning resarch outputs with economic and social needs: too few people understand the role that research plays in developing solutions for industry and community challenges. As stated by one respondent

from KIST, "People here do not understand about research. They seek a result, but they are not interested in the process" (Ibid.). This lack of engagement in the "process," according to a respondent from RDB, includes limited participation by business and community leaders in framing the questions that guide research endeavors, meaning research too often is "not demand driven, [so] it may not answer the needs of the market" (Ibid.).

What actions might be taken to raise awareness about the value of research in addressing market and social needs? One respondent from HEC suggested organizing national events like scientific conferences and research competitions aimed at raising awareness among the public and industry leaders about the utility of research (Ibid.). Others suggested that the One University process, especially the streamlined approach to university resource allocation, will boost the ability of universities to pursue Knowledge Creation (Ibid.).

> **Designing a Well-Aligned Research Agenda**
>
> Consider the 3 D's of Research & Innovation:
>
> - Directionality: Research for What?
> - Distribution: Research for Whom?
> - Diversity: Research by What Means?
>
> (The New Manifesto, 2010)

The New Manifesto, a leading thought piece on aligning STI with development objectives, offers insight on how research agendas might be oriented to meet social and economic needs. No matter the resources available or mechanism for execution, the most important decisions lie in determining the directionality (research for what?); the distribution (research for whom?); and the diversity of the outputs the research agenda delivers (research by what means?) (STEPS, 2010). Without clear guidance on the orientation of research against the "3 D's," research endeavors in Rwanda may continue to be driven by external interests, conceived in absence of many meaningful engagement by national stakeholders.

Forthcoming research policy, if well designed, bodes well for clarifying the current ambiguity on research

Respondents from a variety of perspectives – business, government, and university — noted the need for a national framework on research that clarifies how research should be organized, resourced, and shared. As one respondent from the Rwanda Environmental Management Authority (REMA) stated, "We need a policy on research. We need to know who is doing what. It is about quality control" (Global Knowledge Initiative, 2013). A National Research Policy for Rwanda is currently under review (though many respondents calling for such a framework were unaware of this activity). With the research policy still in production, Rwanda has a unique opportunity to integrate the feedback garnered through the STI Policy review into the research policy language and certainly the implementation process. Namely, the National Research Policy represents an important platform through which to provide guidance on the "3 D's"—directionality, distribution, and diversity—of research to be pursued, and to establish an ethos for research in Rwanda. Might the policy, for example, provide guidelines for international donors in terms of national research priorities ripe for external investment? Perhaps it could offer a suite of incentives and metrics for Knowledge Creation that better reflects the country's needs and opportunities? The utility of the National Research Policy, or the implementation plan that follows, will also be improved by providing direction on *how* Rwanda's researchers might interface with industry and community leaders to ensure their Knowledge Creation pursuits are indeed demand driven.

Respondent feedback on Pillar features not included in Policy

The STI Policy does not explicitly speak to the role of industry in Knowledge Creation. However, interviews with industry leaders highlighted a paradox: they appreciate the value of research, but do not believe their employees have the skills needed to be successful in creating new knowledge. As an executive of ManuMetal stated, "We have not gone into R&D yet because we are not ready. It may be three to four years before we are there" (Global Knowledge Initiative, 2013). An executive of Sulfo, one of Rwanda's leading employers, also pointed to the low skills baseline as a hindrance to Knowledge Creation in business (Ibid.).

Opportunities for learning through exposure to research—which support skill development—appear to be systematically overlooked in a system with such low research production. Namely, the process of framing questions for inquiry, exploring sources for data to refute or support a hypothesis, and producing a coherent synthesis of findings is one that broadly improves STI learning and skill attainment even beyond the more obvious results of knowledge production. Statements from these two private sector respondents underscore the prerequisite exposure to the scientific process that precedes any serious investment in research. This feedback points to an important point not well appreciated in the Policy as currently written: success in one pillar (e.g., Knowledge Acquisition) often bears directly on the ability to achieve positive change in another (e.g., Knowledge Creation). A focused effort to *integrate* activities that rest between and across pillars likely offers a more strategic approach to boosting the contribution of STI for economic and social development in Rwanda. Pillar IV: Innovation Culture further explores the challenges Rwandan businesses face in pursuing knowledge creation and innovation.

Photo: Prototype of a solar panel at Manumetal facility in Kigali. Manumental partnered with a firm in Tunisia to bring this technology to Rwanda;
Credit: Global Knowledge Initiative

"If you cannot transfer innovations, they are useless."

-- Mark Bagabe, Director General,
Rwanda Bureau of Standards

Pillar Three:
Knowledge Transfer

Knowledge Transfer serves as the third pillar of focus for the STI Policy. Priorities within this pillar include ensuring widespread access to the latest technology; establishing links between the people and institutions engaged in R&D and the many needs of industry, the economy, and the community; and establishing S&T Parks. Annex IV provides an overview of other policy priorities and proposed reforms pertinent to Knowledge Transfer as stated in the STI Policy.

Policy features not recognized by respondents

One of the highest priorities of the STI Policy's Knowledge Transfer pillar is the development of an S&T Park in Rwanda. The Government of Rwanda is moving forward with this commitment, having acquired 60 acres near Kigali that will be the home of the country's first S&T park, called Technopole. The stated plan is for Technopole to serve as a hub for ICT-based businesses and the host of US-based Carnegie Mellon University's Rwanda campus and its envisaged ICT Center of Excellence. Despite the significant resources required to launch such a project, only one respondent acknowledged Technopole as an achievement with regard to the STI Policy (Global Knowledge Initiative, 2013).

Additionally, respondents did not acknowledge efforts to create platforms for STI information exchange. Efforts have been made since 2005 to boost the knowledge transfer infrastructure in Rwanda though these went unnoted by interviewees. UbuntuNet, one such project, serves as an ICT-based network linking higher education and research institutions across East and Southern Africa. DSTR supports this initiative and other ICT-based knowledge sharing efforts, such as digital libraries infrastructure for primary and secondary schools managed by MINEDUC (Global Knowledge Initiative, 2013). DSTR and other government entities have also sponsored high-level, international conferences meant to transfer knowledge into and within Rwanda. Examples include the 2007 Connect Africa Summit, the 2007 International Research Conference on Biodiversity and the Sustainable Management of Natural Resources, and the 2008 International Conference on Appropriate Technology. Respondents, however, did not specifically note these as mechanisms for Knowledge Transfer.

Other policy features focused on Knowledge Transfer failed to elicit feedback from respondents because they have not yet manifest through policy implementation. The priority of promoting and preserving indigenous knowledge and community knowledge systems stands as an example of this. While the policy explicitly calls for focus on this need, no evidence of progress in terms of STI Policy implementation exists.

Status of policy implementation derived from respondent feedback

Key Knowledge Transfer trends in Rwanda:
- *Inadequate commercialization and communication of research results hinder potential benefits*
- *Interaction with global knowledge network could be strengthened*
- *Boosting opportunities for industrial attachment and mentorship for students a high priority across sectors*
- *Greater focus on enabling knowledge transfer functions warranted*

Inadequate commercialization and communication of research results hinder potential benefits

According to respondents, Knowledge Transfer between the country's government institutions, universities, businesses, and communities remains a significant challenge, despite being a major priority of the STI Policy. Respondents offered numerous examples of inadequate commercialization and communication of research that highlight this need. According to one respondent from HEC, over last decade, only three academic research outputs were ever commercialized, and other research outputs, "as much as they were good, were hardly ever published" (Global Knowledge Initiative, 2013). Others noted that while some initiatives created to support Knowledge Transfer started off with positive results, they lost momentum due to administrative roadblocks and "unfunded mandates" (Ibid.). For example, the Center for Innovation and Technology Transfer (CITT) at KIST started as a "vibrant" hub for supporting linkages between community needs and university resources (Ibid.). CITT successfully catalyzed the biogas project in prisons, aimed at reducing deforestation, and enabled the distribution of prototypes for agricultural processing equipment (Ibid.). The CITT biogas project won an Ashden Award for environmentally sustainable technology in 2005 (Ashden, n.d.). However, because of changes in university policy regarding how they can raise their funds and other challenges, CITT has become more dependent on donor support and less responsive to the immediate needs of partner communities (Global Knowledge Initiative, 2013). According to respondents, CITT's output and impact have decreased in recent years as a result (Ibid.).

Additional efforts by universities to better connect with communities, such as NUR's mandate for faculty community service targets, have not be fully realized because faculty have not been provided additional time or financial resources to support this work, according to representatives from NUR and HEC (Ibid.). Similarly, according to an NUR lecturer the university's Community Service unit began farmer trainings last year but, due to financial and human resource constraints, "we do not have capacity to go out and share with people what we know" (Ibid.).

Knowledge Transfer between research institutions and industry appears even more tenuous. According to an executive from PSF, "technology transfer [with industry] is only on paper…there is no linkage between enterprise and research institutions" (Ibid.). While some respondents pointed to the lack of funding as a bottleneck for these interactions, others noted that "even when financed, there is still a mismatch between industry needs and university solutions (Ibid.). Evidence of insufficient Knowledge Transfer activities involving Rwanda's private sector spans from advanced technological needs (e.g., reliance on international partners for new mechanical prototypes that cannot be fabricated locally) to issues of basic application (e.g., insufficient use of technology in the management of restaurants, shops, etc) (Ibid.).

Respondents noted the recently initiated Knowledge Transfer Partnership (KTP) as a potential opportunity to spur more active Knowledge Transfer between research institutions and industry specifically. KTP focuses on the interactions between research institutions and industry. Launched in January 2013, the KTP represents a joint initiative of MINEDUC with the African Development Bank (MINEDUC, 2013). MINEDUC and the African Development Bank launched KTP as a mechanism to realize the high potential university-industry partnerships featured in the 2009 study that mapped higher education capacities with expressed industry needs. KTP will allocate 10 million Rwandan Francs per year to each of five partnerships that link university-industry actors for focused problem solving. One respondent from KIST pointed to the creation of the KTP as the most effective reform undertaken under the auspices of the STI Policy (Global Knowledge Initiative, 2013). However, with regard to this review, the initiative is too new and the results too preliminary

to yet be considered a "success" in terms of spurring meaningful Knowledge Transfer between research institutions and industry.

Interaction with global knowledge network could be strengthened

Rwanda benefits from a number of international partnerships that boost Knowledge Transfer with the global knowledge network. Two large industrial firms in Rwanda interviewed for the policy review—Sulfo Industries and ManuMetal—pointed to collaborations with international partners as a major source of knowledge that informs their companies' product offerings and internal processes (Global Knowledge Initiative, 2013). Sulfo Industries, for example, works with a network of international collaborators who directly inform improvements in quality control and serve as sources of new technology that are then integrated into the Rwanda-based operations. A top executive noted that Sulfo's "biggest achievement [has been] to survey the outside for knowledge and [use it] to meet local needs competitively" (Ibid.). ManuMetal, likewise, depends on global partners for Knowledge Transfer. Recently the company partnered with a Tunisian firm to train its engineers on solar panel construction, the skills and knowledge for which the Rwandan engineers then transferred back to colleagues based in Kigali (Ibid.).

> # 98%
> of (formal and informal) businesses in Rwanda are small or medium sized enterprises
> (MINICOM, n.d.)

While these large companies benefit from global Knowledge Transfer, the extent to which small and medium sized enterprises (SMEs) benefit from similar exchanges is less favorable. The policy review elicited no evidence of Rwandan SMEs benefiting from global Knowledge Transfer, actually. In a country where SMEs make up 98% of the businesses, and 41% of all private sector employment in the formal sector, the lack of connection with regional and international partners points to a real challenge for their competitiveness (MINICOM, n.d.). Opportunities for associations or organizations like the PSF to serve as intermediaries for global Knowledge Transfer for Rwanda's SMEs exist, but have yet to be pursued outside of donor contributions (Global Knowledge Initiative, 2013)

Many Rwandan universities boast international partnerships that propel the exchange of knowledge, technology, and other resources. Respondents noted that NUR, for example, was especially proactive in pursuing international partnerships under the leadership of its former Rector Silas Lwakabamba (Global Knowledge Initiative, 2013). The result: ongoing exchanges and collaborations with Sweden, Korea, the US, and other countries.

Strikingly, interview respondents did not acknowledge three of the flagship international university partnerships pursued by MINEDUC in the context of the STI Policy, one with Carnegie Mellon University and two with the Massachusetts Institute of Technology (MIT) through the Climate Observatory and iLAB. Duration may be one explanation for limited recognition among stakeholders: CMU now offers a Masters of Science in Information Technology and in Electrical and Computer Engineering in Rwanda, but classes only began in 2013 (Carnegie Mellon University, n.d.). The CMU campus in Rwanda has yet to be constructed, though a facility is planned within Technopole (Global Knowledge Initiative, 2013). In another example of international university partnership, the Government of Rwanda and MIT's Center for Global Change Science began work toward developing a Climate Observatory on Mt. Karisimbi in 2013. Finally, a partnership between the government and MIT's online laboratory iLab, though established, had not begun programming at the time of publishing this evaluation (Global Knowledge Initiative, 2013;

McGonegal, 2013). Rectors and deans of relevant faculties from KIST and NUR were involved in organizing these partnerships. Once fully operational, these programs are expected to facilitate knowledge sharing between Rwanda's universities, CMU and MIT, and their partners (Global Knowledge Initiative, 2013).

Boosting opportunities for industrial attachment and mentorship for students a high priority across sectors

The STI Policy speaks to the goal of "establishing links between R&D and the many needs of industry, economy, and community." TVET and university students represent a tremendous resource in activating the linkages required for robust multi-sector Knowledge Transfer. However, limited opportunities for industrial attachment and mentoring hinder the ability of students to serve as dynamic intermediaries between institutions of research and training, businesses, and communities. Leaders from the Engineering Department at KIST, the country's leading technical training facility, note that they are severely constrained in how many students they can place in attachments or internships at a given time (Global Knowledge Initiative, 2013). Additionally, respondents pointed to the fact that "people are not mentored" in Rwanda, which poses a major bottleneck for Knowledge Transfer, especially in terms of an impediment to the transfer of tacit knowledge that is not codified in training curriculum (Ibid.). An administrator at KIST corroborated this sentiment, stating: "When we send our students to internships, they sit in desks in corners. No one mentors them. Mentorship would enhance collaboration, but no one does it" (Ibid.).

Many respondents identify finding meaningful ways for students to gain practical experience while supporting Knowledge Transfer as a high priority. Specifically, they highlighted programs that match students with communities to co-create solutions as important. KIST runs "community action programs," for example, that involve students in community-based work (Ibid.). KHI similarly engages students in a range of community-based programs, such as providing medical services to communities and hosting "open days" where the campus is made available to community members (Ibid.). While laudable first steps, these programs

52ⁿᵈ

out of 144 countries in industry-university collaboration (World Economic Forum, 2012)

do not run on the scale required to truly galvanize meaningful knowledge transfer between universities and communities. Respondents raised issues of finances for and faculty management of these programs as additional bottlenecks (Ibid.). Large-scale, well-resourced programs that integrate greater numbers of students and communities are needed if students are to become agents of practical problem solving and Knowledge Transfer in Rwanda.

With regard to student engagement with industry, again the extent of need expressed by respondents points to an opportunity to undertake a more strategic, robust effort to place students into internships and industrial attachments. PSF set up an internship program with the Ministry of Labor, but PSF-affiliated respondents acknowledge it does not go far enough in ensuring the skills and knowledge required for seamless entry into the workplace (Ibid.). Despite this contribution, the challenge of practically-trained students remains a major one for Rwanda. None of the experts engaged through this review offered a clear strategy for how to overcome it. A leader from PSF expressed the desire to "develop something together," acknowledging that a creative solution is indeed possible (Ibid.). Given the cross-cutting nature of the need to produce practically-trained graduates (noted in Pillar I: Knowledge Acquisition), this challenge merits a concerted cross-sectoral response.

Greater focus on enabling Knowledge Transfer functions warranted

Respondents spoke bluntly about their opinions that the STI Policy does not provide enough guidance about how Knowledge Transfer can be spurred and used as an engine for economic and social development. One respondent from KIST commented that the way the policy treats Knowledge Transfer raises "so many questions on this point" (Global Knowledge Initiative, 2013). Another from HEC called for a wholly new structure for fostering links between institutions of higher education and research and industry and communities (Ibid.). A representative of MINICOM's Directorate for Industry Development with oversight over the new SME Clusters program suggested that his office works in isolation of MINEDUC and NCST, despite the fact that the Directorate's mandate overlaps closely with the STI Policy's Knowledge Transfer priorities (Ibid). He stated, "What the STI Policy is doing is what the Ministry of Commerce is doing. We need to stop working in isolation. How do we maximize existing approaches within the government system?"(Ibid.). That said, MINEDUC officials noted the complementary nature of MINICOM's Hanga Umurimo entrepreneurship program and the Rwanda Innovation Endowment Fund (discussed in Pillar IV: Innovation Culture), with the RIEF designed to work in tandem with Hanga Umurimo (Ibid.). The differences in collaboration patterns exhibited between MINEDUC and MINICOM in these two instances point toward the need for more systematic, perhaps formalized knowledge sharing across and within ministries.

In these calls for improved Knowledge Transfer mechanisms, an inherent need to clarify the *functions* and targeted *aims* of Knowledge Transfer becomes apparent. What exactly does the Rwandan innovation system lack that improved Knowledge Transfer—either among local stakeholders or with regional and international partners—can deliver? Only once the "what" question is answered is it appropriate to consider "how" those functions might be manifested in new structures or mechanisms, such as cross-sectoral working groups to address specific challenges identified by SMEs and communities. The STI Policy falls short in this way because it offers solutions for the "*how*" (e.g., through linkage mechanisms) before defining the "*what*" (e.g., to solve *what* specific problem). Understanding the concrete needs to be addressed through Knowledge Transfer activities allows stakeholders to create fit-for-purpose mechanisms designed to deliver results on those areas of need.

In looking ahead, MINECOM's SME cluster program, which seeks to operationalize 22 product clusters for enhanced sourcing of raw materials, processing capability, and business strengthening, offer a potentially ripe platform for engaging in meaningful Knowledge Transfer activities to address specific economic needs. If well facilitated, the SME clusters could provide consensus-based input on their needs—the "what"—after which specific knowledge transfer mechanisms—the "how"—might be designed. Additionally, the newly created KTP could serve as a test-bed of novel approaches to university-government-industry engagement.

Respondent feedback on Pillar features not included in Policy

Respondents highlighted the low baseline of capacity available in communities as a bottleneck to Knowledge Transfer, a reality not acknowledged in the STI Policy. Specifically, respondents noted the lack of basic computer literacy as a major challenge, as it necessitates labor-intensive engagement strategies in which more efficient automated options (e.g., email) could be used (Ibid.).

Photo: Inaugural winners of the Rwanda Innovation Endowment Fund (RIEF) competition receive their prizes; Credit: Global Knowledge Initiative

"Government initiatives have incentivized an ad hoc approach [to promoting innovation]…We need a national process on entrepreneurship, innovation, and capacity building."

-- Hannington Namara, Chief Executive Offer, The Private Sector Federation

Pillar Four: Innovation Culture

The fourth pillar of the STI Policy focuses on promoting an Innovation Culture in Rwanda. Priorities within this pillar include establishing business enterprise centers, establishing district innovation centers, and encouraging private sector partnerships "as a key part of every sector." Annex IV provides an overview of other policy priorities and proposed reforms pertinent to Innovation Culture as stated in the STI Policy.

Policy features not recognized by respondents

Unfortunately, when it comes to STI Policy implementation on promoting an Innovation Culture, secondary research and interviewed respondents offered evidence of few achievements to report. The Rwanda Innovation Endowment Fund (RIEF), a new funding mechanism created in 2012 to support individual and team-based entrepreneurs, received acknowledgement by respondents as an important achievement. However, given that the first awards were distributed only in May 2013, evaluation of success is limited to a mobilization of funding by MINEDUC and UNECA (at USD 50,000 per award, for 8 total awards) and a well-managed awareness campaign and review process. The program, while laudable in its focus on spurring entrepreneurial activity through start-up funding to the next generation of Rwandan innovators, is too preliminary to be reviewed in terms of promoting an Innovation Culture broadly in Rwanda.

Status of policy implementation derived from respondent feedback

Key Innovation Culture trends in Rwanda:
- *Growing constellation of innovation and entrepreneurship programs means thinly spread resources and duplication of effort*
- *Insufficiency of graduates' soft skills, in addition to technical skills, hinders business innovation*
- *Against a history of limited engagement, much scope to activate meaningful public-private partnerships*
- *Pillar priorities highlighted in the National STI Policy miss an essential element: the culture of innovation*

Growing constellation of innovation and entrepreneurship programs means thinly spread resources and duplication of effort

The STI Policy calls for at least four different types of institutional arrangements aimed at promoting innovation in Rwanda: business enterprise centers, district innovation centers, technology incubators / demonstration units, and technology consultation centers. The Policy does not provide details regarding the different role each of these centers / units should play, or how they should be implemented. As such, while some of these centers have come to fruition, the extent to which they constitute a "success" of the STI Policy remains unclear at best.   First, without clearly defined missions or targets for implementation, attribution of policy effects is an elusive goal. Second, respondents noted that while, for example, the District Innovation Centers do exist, according to an administrator at KIST they "aren't really happening" in terms of achieving impact (Ibid.). Similarly, Business Development Centers (which may or may not be the "business enterprise centers" proposed in the Policy) aspire to an important vision of serving as one-stop centers for SMEs in all districts, but according to an attorney who works with the government the BDCs "didn't work well" as implemented (Ibid.).

In practice, a constellation of innovation and entrepreneurship programs now exist in Rwanda, including many that fall outside the scope of the STI Policy. The Box below provides a brief snapshot of seven of these programs. While operational, big questions about their relative and collective impact remain. According to one respondent from PSF, "government initiatives have incentivized an ad hoc approach [to promoting innovation and entrepreneurship]" (Global Knowledge Initiative, 2013). Many of these programs represent stand-alone initiatives that are not integrated with complementary efforts (e.g., there is not a process of handing off entrepreneurship trainees to a funding mechanism like RIEF). Needed is "a national process on entrepreneurship, innovation, and capacity building" (Ibid.). Undertaking an inventory of ongoing entrepreneurship and innovation programs that clarifies programmatic missions, structures, goals, and expected results marks an important first step in initiating the "national process" called for by respondents.

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Box 1: Sampling of Innovation Culture-related Initiatives

Business Development Centers: The Rwanda Development Board administers Business Development Centers (BDC) in Rwanda's 30 administrative districts. BDCs offer Entrepreneurial Development Services, Business Registration, Business Advice and Counseling, IT Services, Business Information Services, Export Development Services, Tourism Information, Tax Advisory Services and Environment Compliance and Cleaner Production Services (RDB, 2013). Through its Human Capital and Institutional Development, and Trade and Manufacturing departments, RDB provides capacity-building services that target potential and current SME operators.

Business Development Services: Similar to the BDC program, the Private Sector Federation operates 30 Business Development Services (BDS) in Rwanda, with one located in every district. They offer a range of services including hosting partners' programs and contracting with independent trainers, improving access to financing by keeping the data base of funding opportunities, and mentoring programs (PSF, 2012).

University Incubation Centers: The Kigali Institute of Science and Technology runs a Technology and Business Incubation Facility (TBIF), which is a program under CITT. TBIF provides incubation services to businesses, and is specifically aimed at recent university graduates (KIST, TBIF, 2013).

KLab Program: KLab is an open technology hub in Kigali. Students, recent graduates, and others who are accepted into the competitive KLab program are able to use the space, technology infrastructure, and the expertise of staff, to start their businesses (KLab , 2012).

Rwanda Innovation Endowment Fund: The Rwanda Innovation Endowment Fund (RIEF) offers funding opportunities for research and development on potentially transformative innovations developed by individuals or groups, generally recent university graduates. Innovators working through this program are given a prize of approximately $50,000 USD (MINEDUC, 2012).

Hanga Umurimo Program: Hanga Umurimo aims to build technical capacity of entrepreneurs to manage their businesses efficiently. Run by the Ministry of Trade and Industry, it aims at speeding up the process of off-farm job creation. It offers training opportunities to innovative business ideas and connects successful business plans to sources of financing (SME Portal , 2012).

Business Development Fund: BDF is an affiliate of the Rwanda Development Bank, set up with the support of the Ministry of Trade and Industry and other government bodies with the aim of enhancing financial institutions' lending mechanisms to private as well as public clients. BDF exists to ameliorate challenges faced by SMEs in accessing financing. The fund provides technical assistance, and provides up to 75% of collateral and equity funding to specific projects (Business Development Services, 2011).

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Insufficiency of graduates' soft skills, in addition to technical skills, hinders business innovation

Private sector leaders that participated in this study consider "innovation," in terms of creating new products and processes for the marketplace, a long way off given their current employee base. The challenge represents a confluence of insufficient technical skills (as highlighted in the Knowledge Acquisition pillar) as well as lacking soft skills such as in communication and management. As one respondent from NUR asked, "How can you innovate if you don't have the basics?" (Global Knowledge Initiative, 2013). The lack of basic soft skills — which, according to respondents, often are not the focus of a technical degree program — keeps employers from having full confidence in the creative capacity of those they hire (Ibid.).

Beyond basic skills for communication, business, and management, others from academia noted both a lacking appetite for risk and a missing sense of curiosity that further dampens the innovation pursuits of business (Ibid.). Efforts to increase these intangible characteristics of innovators are underway in Rwanda, in part through the initiatives listed above and also through the formal education system. The Government of Rwanda, for example, recently included entrepreneurship training as a compulsory element of secondary education (Global Knowledge Initiative, 2011). KIST now requires all students to complete an entrepreneurship course that includes a finance / economics component (Global Knowledge Initiative, 2013). Additionally, PSF supports capacity building for business management, finance, product standardization, and other "soft" skills highlighted above (Ibid.). A number of international organizations, including USAID and JICA, provide training to Rwandan youth aimed at improving their entrepreneurial and business acumen (USAID, 2013; MINICOM, 2013).

The challenge in developing and mainstreaming such programs, according to a PSF executive, is "planning for the private sector we have, not the private sector we want" (Global Knowledge Initiative, 2013). Creating an aspirational vision of where you want to move is critical to achieving transformational change, as illustrated by the mobilizing power of Vision 2020. However, stakeholders must also be willing to acknowledge and grapple with the capacity deficits that face Rwanda. Programs that bridge the gap between aspiration and reality merit substantial energy, coordination, and resources.

Against a history of limited engagement, much scope to activate meaningful public-private partnerships

Overall, private sector respondents engaged in the review expressed a low awareness of the STI Policy compared to their government and university counterparts, with some only learning of the policy through the review process itself. Those who did know of the policy acknowledged a lack of engagement on its implementation since 2005, though recent efforts at collaboration have been initiated by both MINEDUC and NCST (Global Knowledge Initiative, 2013). From the university perspective, an NUR respondent expressed the opinion that the "private sector in Rwanda is not well structured…not well defined," which has hindered university-industry engagement (Ibid.). An RDB respondent corroborated, stating a disconnect exists between what the private sector does and what centers of knowledge do (Ibid.).

This disconnect has persisted, one UNESCO respondent noted, because of "a lack of institutions to improve [and] give links [with private sector]" (Ibid.). However, this same person acknowledged that the creation of NCST offers an opportunity to pursue these

connections with more focus and vigor (Ibid.). Others suggested the creation of a permanent consultative body that regularly brings together government, industry, and university leaders (Ibid.). PSF and RDB co-chair a platform for public-private partnership dialogue, which could serve as a potential focal point for enhanced collaboration on STI Policy implementation (Ibid.). There is not, it seems, a deficit of potential platforms for improved dialogue and planning, nor of individuals and institutions ready to engage. Rather, Rwanda requires strong leadership to galvanize systemic change, and a highly visible, participatory process to manifest public-private partnerships.

Also, as noted in Pillar III: Knowledge Transfer, stakeholders must first determine the "what" of public-private partnerships for promoting an Innovation Culture. Only then can the mechanisms that deliver responses to needs and opportunities — the "how" — be purposefully and meaningfully addressed.

Pillar priorities highlighted in the STI Policy miss an essential element: the <u>culture</u> of innovation

Respondents offered a number of ideas about what it means to have an Innovation Culture. As one respondent connected to the National Reference Laboratory put it, "Innovation is a culture of thinking…Asking questions is key to this…And then there's courage to take a risk….To innovate is to accept that something may not work, but you can still learn" (Global Knowledge Initiative, 2013). However, in terms of becoming an Innovation Culture, respondents believe that Rwanda remains a risk-averse environment in which the fear of failure persists, and incentives for risk-taking are not yet robust enough to encourage innovation (Ibid.). These features are entrenched in Rwandan culture and history, say some respondents. Any attempt to change culture requires long-term investment, sustained commitment, and a collective sense of what this new culture should espouse (Ibid.).

Understanding this context for innovation in Rwanda, it is striking that although the policy highlights promoting an "Innovation Culture" as a leading priority, none of the policy directives or proposed reforms define steps to catalyze such a cultural shift. The directives offer no insight or suggestion of what should be done to imbue an ethos of innovation in Rwanda. This policy pillar more so than others stresses institutional mechanisms — centers — instead of functions as a means to the desired end (e.g., a culture of innovation that increases the rate and impact of Rwandan innovation).

Important questions that must be answered in migrating from policy review to policy update and implementation include: What is the culture of innovation that Rwanda wants to pursue? What innovation ethos represents the unique culture, history, resources, and aspirations of Rwanda, and is thus worthy of being promoted by national initiatives? What steps are needed to enable this cultural shift? The policy review highlighted these provocative questions, but answering them falls outside of the scope of the evaluation. Rather, the Government of Rwanda has a unique opportunity to take on these questions during the forthcoming policy update and implementation strategy formulation processes.

<u>Respondent feedback on Pillar features not included in Policy</u>

Respondents pointed to structural challenges facing Rwandan that impede the promotion of an Innovation Culture, though the Policy does not provide any treatment of these issues. The high costs of energy and transport elicited mention as structural issues that hinder innovation in the country (Ibid.).

"Creating meaningful and long-term change through science, technology and innovation requires robust baseline data, targets, and mechanisms to improve on existing programs and to create new ones."

-- Remy Twiringiyimana, Acting Director General, Directorate of Science, Technology and Research, Ministry of Education

Notional STI Policy Indicators

The Status of STI Data in Rwanda

To most accurately analyze the impact of a policy toward a specific set of aims, a plan for implementation underpinned with baseline data and targets is required. However ambitious or mundane a policy goal, without baseline data or targets, it is difficult to monitor its progress or evaluate success. In the case of Rwanda's STI Policy, the lack of robust indicators obviates a straightforward evaluation.

This evaluation largely focuses upon qualitative data from interviews and surveys given the lack of specific data and targets eight years after the Policy's publication. Ideally, targets would have been developed within an implementation plan forged shortly after the policy's adoption. The absence of an action plan is an issue MINEDUC, NCST, and partners seek to rectify soon.

In the interim, one can explore a number of proxy indicators available through primary and secondary research. In fact, a close reading of the STI Policy enables a reader to envisage numerous indicators that would facilitate M&E for each policy pillar. To equip the Government of Rwanda to adopt a more rigorous approach in future STI Policy iterations, the review team presents notional indicators that were selected from dozens considered. The team considered contenders that can be used to gauge how successful specific STI investments / program have been in propelling Rwanda toward its overarching goals of Knowledge Acquisition, Knowledge Creation, Knowledge Transfer, and Innovation Culture. For each candidate indicator the review team sought data at two points in time. First, the team sourced data as close to 2005 as possible, thereby establishing a baseline. Second, the team sought data as close to the current moment as possible, thereby revealing change over time. The result is an indicator dashboard presented in the following pages.

The STI Policy Indicator Dashboard

The following STI Policy Indicator Dashboard is meant to provoke debate and inspire selection of optimal indicators, be they identical, similar, or vastly different to the 12 included. The dashboard represents an effort to aggregate data describing national achievements in Knowledge Acquisition, Creation, and Transfer, and in developing an Innovation Culture. Although we make no causal statements implying a relationship between the STI Policy and STI achievements noted in this dashboard, we have searched for data from 2005 when available, and compared it to the most recent data available (generally from 2012 or 2013). In the case of World Economic Forum data, these indicators are only available from between 2010 and 2012. All others, though, go back to at least 2008. This data was collected through secondary research and through interviews in Rwanda. Taken together, the data reveals two important themes that bear on STI: (1) Rwanda's legacy of fast, but uneven economic and social development, and (2) the need for better, more accurate baseline data, and robust, specific, achievable targets. In sum, Rwanda's rapid economic growth often outpaced policy implementation or rigorous monitoring of implementation.

Although helpful, this dashboard is not without its weaknesses. Beyond the scarcity of data, these data points may not always represent broad national trends. For example, the review team believes the change in the proportion of students with internships or industrial attachments at KIST, Rwanda's largest technical university, constitutes a national issue. However, one could make an argument that KIST's internship program represents an outlier. Additionally, the dashboard does not speak to causation: the STI Policy itself did not necessarily contribute to each of these indicators. Rather, the review team undertook this

exercise to understand what changes have taken place within Rwanda relevant to the STI Policy's broad goals and provoke construction of an optimal set of indicators and targets in the coming months.

Box 2: Overview of Notional STI Policy Indicators

Pillar I: Knowledge Acquisition

- ***Proportion of students studying science:*** At Rwanda's three biggest public higher education institutions (NUR, KIE, KIST), the proportion of students studying science rose from 35.75% in 2005 to 42.31% in 2012.
- ***Percentage of students with industrial attachment:*** In 2008, 13% of KIST students had an internship or industrial attachment. By 2012, that proportion climbed to 22% of students.
- ***Teachers trained on science teaching kits:*** JICA's Strengthening of Mathematics and Science in Secondary Education" (SMASSE) program, which had not yet begun in 2005, has trained 10,973 secondary teachers how to use science/experiment kits by 2011 (their goal is to train 100,000).

Pillar II: Knowledge Creation

- ***Quality of research institutions:*** The World Economic Forum began including Rwanda in their Global Competitiveness Report in 2010. Between 2010 and 2012, Rwanda moved from 95th in the world in "Quality of Research Institutions" to 69th in the world.
- ***Researchers' rate of publication:*** In 2005, Rwandan researchers published 0.022 science and technology articles per 10,000 people. By 2012, that number had risen to 0.162 science and technology articles per 10,000 people.
- ***Proportion of university budgets supporting research:*** The average expenditure on research and publication across the two largest public universities (NUR and KIST) was 1.24% in 2008 and 0.88% of the overall budget in 2012-2013.

Pillar III: Knowledge Transfer

- ***University-industry collaboration:*** Between 2010 and 2012, Rwanda moved from 65th in the world in "Industry-University Collaboration" to 52nd in the world.
- ***Availability of technology hubs to foment linkages:*** The number of technology hubs (defined as tech transfer and incubation centers) increased from four in 2005 (three CITT centers and TBIF) to eight in 2013. A ninth is starting in 2015.
- ***Intellectual property (IP) rights policies at HEIS:*** Of the five biggest public higher learning institutions (NUR, KIST, KIE, SFB, Umutara Polytechnic), none had intellectual property rights policies in 2005. In 2013, only NUR and Umutara Polytechnic had policies (KIST had one sentence in its research policy about IP).

Pillar IV: Innovation Culture

- ***Connections with private sector:*** In terms of private sector growth in "forged connections", data is currently unavailable. Potential measurement strategy: use pre- and post-surveys or interviews of PSF members or others to gauge forged connections in private sector
- ***Availability of support for business development and innovation at local level:*** In 2008, 30 district tele-centers were developed. These became Business Development Centers, managed by the Rwanda Development Board, in 2010.
- ***Mechanisms to support commercialization:*** In 2005, there were no government mechanisms to support commercialization and entrepreneurship. In 2013 there were three: MINEDUC's RIEF, Rwanda Development Bank's Business Development Fund, and MINICOM's Hanga Umurimo.

Implications of selected indicators:

Based on the notional indicators selected for the Indicator Dashboard highlighted above and described in detail below, development in STI over the past eight years represents a mix of successes and — importantly — programs or growth areas for which achievement eludes clear measure. As validated in interviews, some promising surges forward (such as in publication, proportion of students studying science, and development of Business Development Centers) offer contrast to lagging indicators, especially in policy and funding for research. In short, these data points provide a picture of fast but spotty growth in STI.

One of the most important lessons from this exercise, though, has to do with the dearth of useful data available. These indicators, while interesting, do not provide a comprehensive picture of growth in STI over the past eight years largely because important data either was not gathered or is not publicly available. Although it is possible to cobble together a rough picture of improvements or stagnation in STI through post hoc development of indicators, such efforts do not make up for the lack of baseline data against which to measure success on specific goals. Gathering data at regular intervals helps to facilitate iterative planning and adaptation, which in turn fuels progress.

Below, see the "STI Indicator Dashboard" for selected indicators. For additional information on data elicited through the Survey Protocol, see Annex II.

Knowledge Acquisition and Public Sector Reform: Indicator #1

Percentage of university students studying STEM increased from 35.75% in 2005 to 42.31% in 2012

University students studying STEM

2005	35.75%
2012	42.31%

Notes: Although in 2013 all of KIST's students study STEM subjects, in 2005 only 46% of KIST students studied STEM. The creation of the School of Finance and Business meant that some courses previously within KIST were no longer taught there. GKI developed metrics to designate those majors considered STEM, but other interpretations are valid.
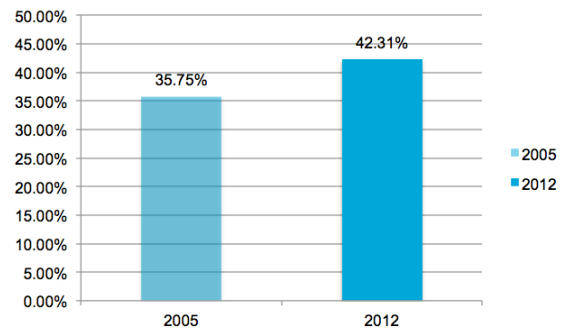
Methodology: The proportion of university students studying science, technology, engineering, and math (STEM) is calculated based on data provided by NUR, KIST, and the Kigali Institute of Education (KIE). They are defined as individuals studying hard sciences, engineering, technology, and math. Behavioral sciences and humanities are not included.

Knowledge Acquisition and S&T Outreach: Indicator #2

Percentage of KIST students with an internship increased from 13% to 22% between 2008 and 2012

KIST students with internships

2008	13%
2012	22%

Notes: KIST collects data on the number of students with an internship or industrial attachment annually. The proportion of students with an internship has risen. However, KIST's spending on internships and industrial site visits has dropped from just over 176 million RF in 2008 to 87.6 million RF in 2012-13.
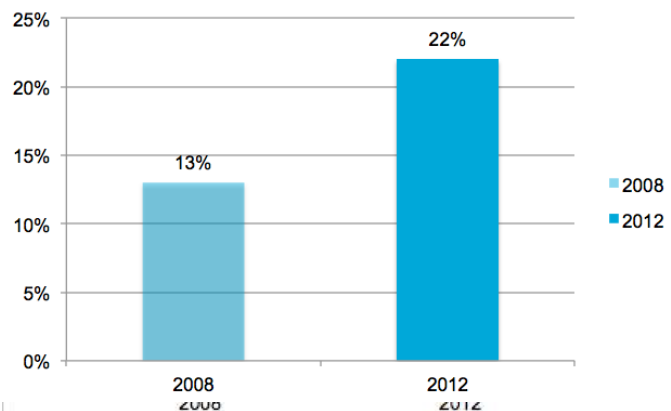
Methodology: The percentage of KIST students with an internship is defined as those students with an internship or industrial attachment that is known of or organized by the school. This data was provided by KIST.

Knowledge Acquisition & Incentives for Implementation: Indicator #3

In 2005, no Rwandan teachers had been trained by JICA on using science kits. By 2011, 10,973 had been taught.

Teachers trained by SMASSE

- 10,973 (2011)
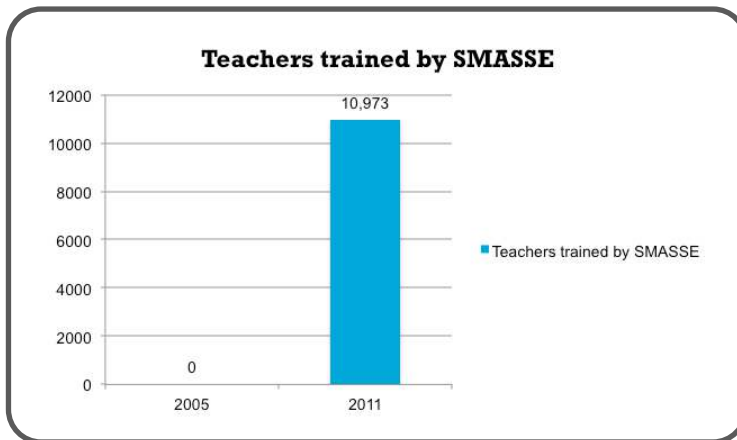- 0 (2005)

■ Teachers trained by SMASSE

Notes: JICA reopened its Rwanda office in 2005, the year the STI Policy was launched. Its SMASSE project was a replication of the successful SMASSE Kenya program, which began in 1998.

Methodology: The number of teachers directly taught through the SMASSE (*Strengthening Mathematics and Science in Secondary Education*) is listed on the JICA website, and is also available through news stories in the New Times. Many more teachers are expected to be taught by these first teachers who can now teach more experiential and lab-based science using science kits.

Knowledge Creation and Public Sector Reform: Indicator #4

Between 2010 and 2012, Rwanda moved from 95th to 69th in the world in the "Quality of Research Institutions"
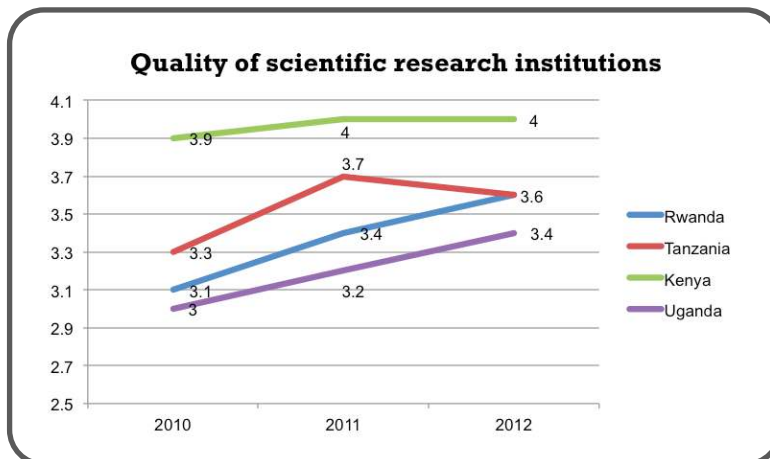
Quality of scientific research institutions

- Rwanda
- Tanzania
- Kenya
- Uganda

Notes: Because WEF uses a non-random survey of business professionals to develop the GCR, there is the potential for bias. In Rwanda's case, there is a possibility that Rwanda does not have as high quality research centers as respondents perceive, owing to a possible lack of comparators. For example, Rwanda's research centers may not be as high quality as those in Russia or Colombia, which scored lower.

Methodology: The World Economic Forum (WEF) uses the Executive Opinion Survey to develop many of the answers in their Global Competitiveness Report (GCR). In 2010, they added Rwanda to the GCR with Rwanda ranked 95th in "Quality of Research Institutions", earning a score of 3.1 out of 7. In 2012 it moved to 69th with a score of 3.6.
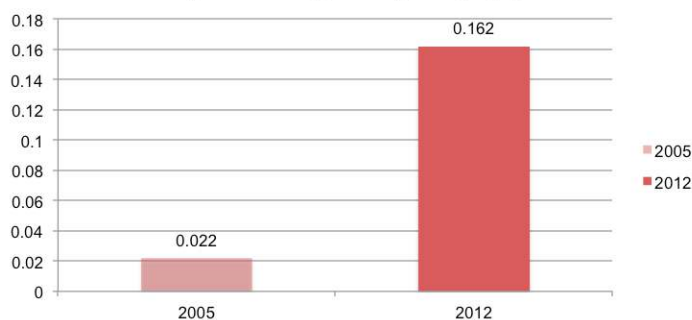
Knowledge Creation and S&T Outreach: Indicator #5

In 2005, Rwandan scholars published 0.022 academic papers per 10,000 pop. compared to 0.162 by 2012

S&T Papers published in academic journals (per 10,000 pop.)

- 2005
- 2012

2005: 0.022
2012: 0.162

Notes: Papers tracked by the Web of Science may tend to underrepresent researchers publishing in Africa and other developing countries. One reason for this is the focus on English language publications. Another is the lack of local/regional journals. This number still provides a useful data point, though, on Rwandese researchers' inclusion in international scientific publication.

Methodology: Academic publications in science, engineering, and technology are measured using Thomsen Reuters Web of Science. By sorting for strictly those papers with Rwandan authors and in the hard sciences, engineering, and technology (excluding humanities or behavioral sciences), one can establish the number of scientific papers published each year.

Knowledge Creation and Incentives for Implementation: Indicator #6

Avg. research budgets for two largest public HEIS dropped from 1.62% in 2008 to 1.48% in 2012-2013

Budget going to Research & Publication

- 2008
- 2012-13

2008: 1.62%
2012-13: 1.48%

Notes: KIST and NUR provided their budgets 2008 and fiscal year 2012-2013, including funding going to research and publication. These numbers do not include non-budgeted, external funding for research (such as from donors).
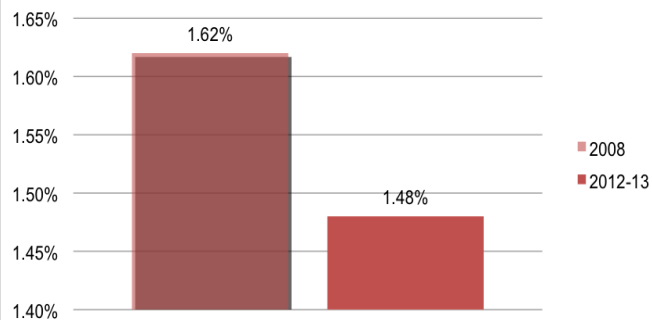
Methodology: The percentage of budgets going to research and publication was calculated by dividing expenditures on research and publication in 2008 (the earliest statistic available) and 2012-2013 by overall budgets in those years. The budgets do not include external support and consultancies, which would not be budgeted for.

Knowledge Transfer and Public Sector Reform: Indicator #7

Between 2010 and 2012, Rwanda moved from 65th to 52nd in the world in "University-Industry Collaboration"

University-Industry Collaboration in R&D

Year	Rwanda	Tanzania	Kenya	Uganda
2010	3.6	3.4	3.8	3.4
2011		3.7	3.9	3.5
2012		3.8	4.2	3.6

Notes: Because WEF uses a non-random survey of business professionals to develop the GCR, there is the potential for bias. In Rwanda's case, there is a possibility that Rwanda does not have as strong univer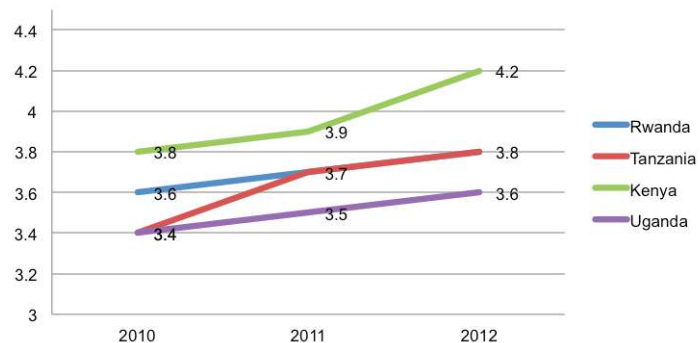sity-industry collaboration as respondents perceive, owing to a possible lack of comparators. This is especially likely to be the case given interview responses in the STI Policy Review.

Methodology: The World Economic Forum (WEF) uses the Executive Opinion Survey to develop many of the answers in their Global Competitiveness Report. In 2010, they added Rwanda to the GCR. In 2010, Rwanda was 65th in "Quality of Research Institutions" with a score of 3.6 out of 7 and in 2012 it moved to 52nd with a score of 3.8.

Knowledge Transfer and S&T Outreach: Indicator #8

The number of government-supported tech hubs rose from 4 in 2005 to 8 in 2013

Publicly supported tech hubs

	2005	2013
	4	8

Notes: The four technology hubs in Rwanda in 2005 were CITT's three centers, plus TBIF. As of 2013, all four of these centers were still active, as was K Lab, the RDB Masaka Business Incubation Center, the National Data Center, and the Technology and Innovation Support Center.
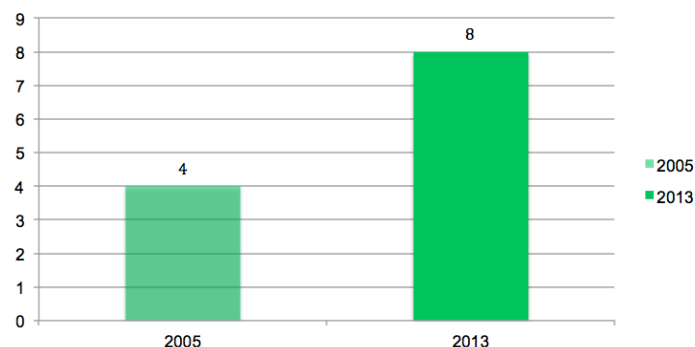
Methodology: Technology hubs are defined as incubators, demonstration units, and technology transfer centers—all entities called for in the STI Policy. The number of existent hubs was established through interviews and secondary research.

Knowledge Transfer and Incentives for Implementation: Indicator #9

In 2005 none of Rwanda's top 5 largest public universities had IP policies; in 2013 2 did.

HLIs with and without IP Policies (largest 5 public HLIs)

40%
60%

- HLIs with IP Policy
- HLIs without IP Policy

Notes: NUR and Umutara Polytechnic are the only members of the largest 5 public universities to have published intellectual property rights policies. KIST has a sentence in its Research Policy that deals with IP, but it does not constitute a policy.
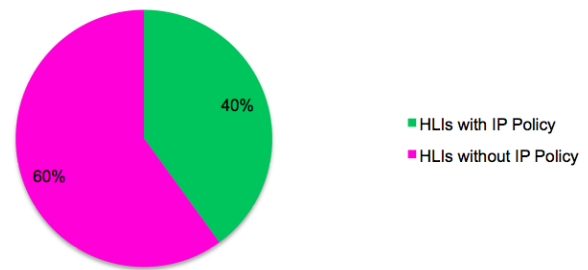
Methodology: Existence of public intellectual property rights policies was established using textual research and through interviews with stakeholders at Rwandan universities. The top five largest public universities are: NUR, KIE, KIST, Umutara Polytechnic, and SFB.

Innovation Culture and Public Sector Reform: Indicator #10

Growth in private sector forged connections

Measuring private sector forged connections

Notes: The research team reached out to PSF for information on membership, but did not receive any information. Instead, we developed a suggested indicator.
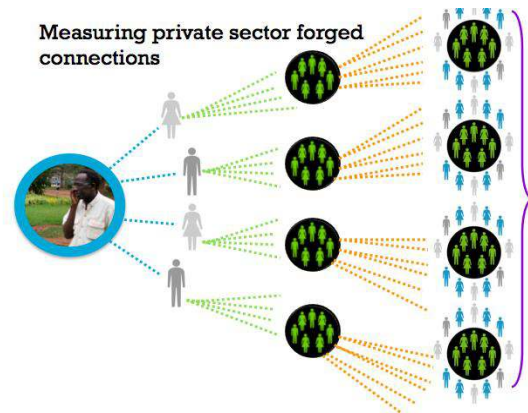
Methodology: Interviews or surveys can be designed to measure private sector connections forged. By gathering baseline data from a meaningful sample of PSF members, and asking them about their forged connections at a pre-determined later date, Rwanda could track a meaningful (if imperfect) indicator on private sector forged connections.

The number of district Business Development Centers grew from 0 in 2005 to 30 in 2008

Districts with Business Development Centers

Notes: Business Development Centers (BDCs) began as rural "tele-centers," but became BDCs in 2010. The Rwanda Development Board manages them as they support rural communities in business development. They typically have computers, internet, and individuals able to give advice.
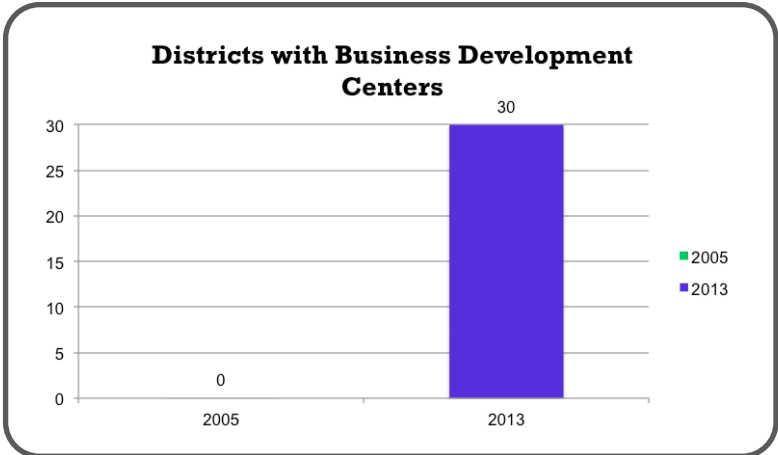
Methodology: Business Development Centers exist at the district level, and are designed to help individuals start businesses. As of 2013 there remain 30 working Centers, one in each government district.

In 2005, there were no gov't mechanisms for commercialization support. In 2013 there were 3.

Funding mechanisms for SMEs

Notes: The RIEF program was inaugurated in 2012 to provide seed funding to young entrepreneurs commercializing innovations. The Business Development Fund provides collateral and direct funding to SMEs. Similarly, Hanga Umurimo provides long-term financing to entrepreneurs.
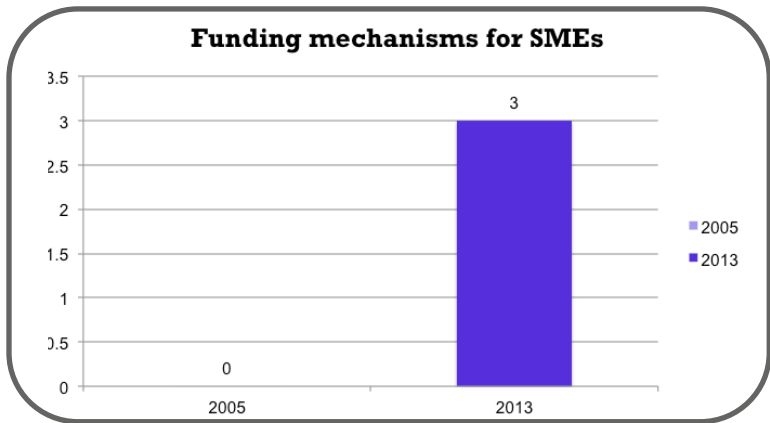
Methodology: Interviews and textual research identified three government mechanisms for commercialization: MINEDUC's Rwanda Innovation Endowment Fund, Rwanda Development Bank's Business Development Fund, and MINICOM's Hanga Umurimo Program. These are defined as government programs providing financing or grants to entrepreneurs for commercialization/starting businesses.

Photo: Maraba Coffee Washing Station; Credit: Global Knowledge Initiative

"[The STI Policy review] has given us the elements of a framework for strengthening STI in Rwanda."

-- Ignace Gatare, Director General
National Science and Technology Commission
(From the June 2013 STI Review Stakeholder Workshop)

Recommendations and Strategy Formulation Considerations

The recommendations below emerged from the review team's analysis of the interviews, surveys, stakeholder workshop outputs, and background literature. Recommendations are organized into three categories: those that pertain to the policy itself and beckon for an update to policy language; those that relate to STI governance structures; and, and those that underscore the need to improve policy implementation.

Recommendations pertaining to a revision of the STI Policy

> *The review process revealed the need to update the STI Policy in a number of instances. The following recommendations are those the review team deems to be of highest priority.*

(1) **Streamline policy priorities to improve coherence and reduce duplication.** All told, the 2005 STI Policy includes 21 capacity building objectives (organized within the four pillars), 14 sector strategic statements, 29 government reforms, and a host of other goals / priorities. Among these 64+ priorities, some represent high-level goals (e.g., advance indigenous small and medium-sized enterprises) while others constitute more discrete objectives (e.g., exempt equipment and material imported for R&D activities from taxes). However, the policy presents these diverse priorities under a common heading of "government reforms," for example, without acknowledging the apples-and-oranges assortment of reforms presented. The result: a less coherent vision for transformation and an ambiguous organizing principle for the policy. Additionally, because the policy presents so many priorities, duplication across the capacity building objectives, sector strategic statements, and government reforms occurs, again reinforcing the sense that the policy does not present a coherent vision for change. The review team recommends that an update of the STI Policy be undertaken to (1) parse high-level and discrete objectives and organize them into a coherent framework; and (2) compare side-by-side the priorities presented in the capacity building objectives, sector strategic statements, and government reforms; remove duplicative priorities; and condense overlapping priorities where possible. The review team believes such changes will streamline the policy such that it presents a more compelling, approachable vision for STI in Rwanda.

(2) **Focus on STI functions required for change, not institutional mechanisms.** Currently, the STI Policy proposes an assortment of institutional structures aimed at delivering benefits rendered through STI. Within Knowledge Transfer, these include S&T Parks, Technology Consultation Centers, and Demonstration Units. Within Innovation Culture, these include Business Enterprise Centers and District Innovation Centers. The policy, however, fails to define what really matters most in spurring STI for socio-economic development, namely what functions/benefits/roles these institutions are designed to deliver, who they mean to serve, and how they will achieve these goals. This means, as written, the creation of a technology consultation center might be deemed a policy achievement even if it provides sub-par services to a negligible number of people. Moreover, without further explanation of the functions (i.e., the roles) the institution is meant to play, it is very difficult to determine whether existing institutions, such as the Business Development Centers run by the Rwandan Development Board, are or are not the same institutions called for in the policy as Business Enterprise Centers.

In short, the reviewers recommend that the priorities given as institutional mechanisms be reoriented to present the functions (i.e., the what, how, and who) that an institution is meant to perform. For example, Business Enterprise Centers are currently offered as a priority for cultivating an Innovation Culture in Rwanda. However, no detail is provided regarding the role these centers are meant to play in cultivating an Innovation Culture. What gap(s) are they meant to fill? How are their services to be delivered? Who are they meant to serve? Without providing insight into these questions of function and form, the policy presents a "solution" without first defining the problem to be addressed. The review team recommends that the STI Policy define the Innovation Culture needs/gaps to be addressed, then use the forthcoming implementation strategy to present institutional structures that might be used to address these needs/gaps as defined in the policy. In this way, the policy will maintain a focus on high-level reforms (e.g., build entrepreneurial capacity of SME workers, provide a platform for cross-sector information exchange between SME workers). The implementation strategy, then, will provide the platform to offer pragmatic approaches and targeted benchmarks of success toward executing the reforms proposed in the policy (e.g., establish Business Enterprise Centers that serve X number of people toward achieving certain specified outcomes).

Recommendations regarding STI Governance

The review process highlighted a number of challenges with STI Governance that warrant action. The following recommendations focus on those actions the review team deems highest priority from the findings elicited.

(3) **Create an STI Policy implementation strategy including baselines of STI investment / achievement and clear targets for progress.** As noted previously, the 2005 STI Policy does not include an implementation strategy or a monitoring and evaluation (M&E) framework. Similarly, no baselines of investment or achievement were established upon the approval of the policy, meaning there is no definitive way to measure change (positive or negative) since STI Policy implementation began. Regardless of these historic omissions, it is imperative that the current baseline of STI investment and achievement be established, and that clear targets for measuring progress are defined. This effort should closely map to the national priorities and targets established in the revised Vision 2020 and EDPRS II. The Ministry of Education's DSTR and the newly established NCST both acknowledge M&E as a priority need for furthering STI Policy implementation, and plan to incorporate it as the focal point in the forthcoming strategy formulation process. The review team fully supports this commitment, and recommends that establishing a clear baseline of STI investment and achievement be taken as a central aspect of this work.

(4) **Support STI priority distillation from key sectors.** Although the STI Policy rightly includes sectoral STI priority statements from a range of critical areas—agriculture, health, ICT, etc.—missing is a mechanism that defines those aspects of key sectors that warrant support from a cross-sectoral STI policy/governance mechanism. Interviewees acknowledged that STI activities occur within the sectors even in isolation from the entity currently charged with implementing the STI Policy (e.g., DSTR). Improving the means of STI Policy implementation means making

explicit the manner in which a challenge at sectoral level—say, increasing the value of Rwandan tea exports—can be transmitted into the STI governance mechanism such that STI-relevant advice is dispensed, opportunities for STI promotion/use are illuminated, and a better outcome in terms of sectoral goals (agricultural sectoral goals in this example) becomes more likely. Achieving such integration between each of the sectors and the STI governance mechanism will require clarity in terms of DSTR and the newly formed NCST's roles and structures. Similarly, the review team recommends devising a more functional interface through which STI Policy implementers can liaise with industry, academia, and civil society.

(5) **Maintain institutional consistency as a way to build momentum for STI**. Ever-changing institutional structures for STI governance characterized the 8 years following approval of the STI Policy, as noted in the introduction section. Over this timeframe, the responsibilities for STI Policy implementation moved from a stand-alone Ministry to MINEDUC, where further changes to the DSTR office structure continued. The recent introduction of the NCST (currently located in the Prime Minister's Office) further reflects the pattern of change in STI governance in Rwanda. It is too soon to know how the introduction of NCST will impact STI policy implementation in the future, as the Commission is not yet fully operational. However, one thing is apparent: the constant state of flux within STI governance structures contributed to a lack of momentum for, and awareness of, the 2005 STI Policy and its implementation. The review team strongly recommends that a strategic framework for STI governance be designed and decided upon, and that it be maintained over the long-term (i.e., not changing every 2-3 years). Such a commitment to a structure will provide STI proponents a consistent platform through which to build stakeholder awareness (and trust). Committing to a governance structure also ensures that actors operate within an environment better suited to the time frame for action required to implement meaningful programs that mobilize STI for achievement of Vision 2020 and EDPRS II.

(6) **Orient STI institutions (e.g., DSTR, NCST) to cultivate innovation systems functions that fall outside of traditional mandates.** The Rwandan innovation system has an ample (though not robust) number of institutions working to create new knowledge, train future technicians and engineers, and distribute products into the market. These institutions, whether they are universities, private companies, or line ministries, are steadily improving at delivering on their core missions. Still largely missing from the Rwandan innovation system are those organizations that focus primarily (and actively) on creating linkages among traditional actors (e.g., universities, companies, government ministries). This means that those important innovation system functions that reside outside traditional mandates — such as transferring knowledge from universities to communities, or ensuring future graduates gain access to industrial attachments — end up being no one's job. STI institutions such as DSTR and NCST have a unique opportunity to fill this gap. The policy review process identified a number of needs for which no entity currently takes responsibility. The review team recommends that these needs be further highlighted and explored in the forthcoming STI strategy formulation process.

Recommendations regarding STI Policy Implementation

The review process unearthed a number of findings pertinent to STI Policy implementation that merit mention in the evaluation report. The following recommendations highlight those actions the review team deems highest priority.

(7) **Remove administrative barriers to Knowledge Creation.** Stakeholder feedback revealed an alarming reality in Rwanda: numerous administrative bottlenecks restrict the research enterprise. The recent policy from MINECOFIN eliminating intergovernmental transfers (thus restricting MINEDUC from transferring post-doctoral research support funds directly to universities among other things) and the burdensome procurement policy represent two oft-cited challenges. Given the nascent research enterprise in Rwanda, government is advised to consider all steps possible to remove barriers to knowledge creation. The government has received international recognition for its work to streamline business administration processes, such as those related to starting a new business in Rwanda. Minimizing the administrative burden for research warrants similar effort. Without making progress on bottlenecks within the government's control, it is unlikely that more onerous challenges associated with Knowledge Creation (e.g., boosting research budgets) will achieve discernible progress in the coming years.

(8) **Minimize thinning of resources across multiple innovation support programs and institutional arrangements.** Within the pillar of Innovation Culture, the review process revealed a proliferation of entrepreneurship and innovation support programs in Rwanda. The commitment to supporting entrepreneurs and their potential innovations is laudable, and the review team supports this trend in investment. However, the sheer number of programs, and the lack of integration among them, warrants investigation. Specifically, the review team recommends a mapping of current entrepreneurship and innovation support programs (such as those listed on page 39) to determine whether current resources are being used to maximum impact. Many of these programs on the surface seem to offer similar services to similar constituencies. As such, the review team speculates there may be efficiencies to be gained, or duplications to be minimized. This assumption needs to be tested. No matter whether monetary resources can be better maximized across these programs, there appears to be a ripe opportunity to improve support for entrepreneurs / innovators by making the hand-off between programs more explicit. For example, to what extent does the Hanga Umurimo Program prove complementary to the Rwanda Innovation Endowment Fund, as asserted by MINEDUC officials? Do individuals that request support from University Incubation Centers (such as TBIF) also receive access to the Business Development Fund? The review team recommends clarifying the "bridges" between existing programs such that potential beneficiaries are pointed toward the programs most suited to accommodate their needs at each stage of the innovation journey.

(9) **Implement community-focused STI programs, not "unfunded mandates" for community engagement.** The review of the STI Policy revealed a dearth of programs explicitly focused on addressing community needs through the application of STI. A few initiatives highlighted the desire of universities, for example, to be more actively engaged in community outreach programs. However, community

engagement programs can end up being "unfunded mandates" that do not get implemented because there are no resources to support the involvement of faculty members and students. The review team acknowledges the importance of creating explicit STI programs aimed at directly addressing community challenges, and recommends that a dedicated source of funding be identified / created to support this type of work. Additionally, the review team encourages STI proponents to consider establishing an award program or merit-based competition aimed at boosting the application of STI for community problem-solving. Space exists for Rwanda to become a regional, if not global, leader in the application of STI for community development. However, such leadership requires a tangible commitment of resources.

Next Steps: Policy Update and Strategy Formulation

Two steps will follow the STI Policy review process: (1) an update of the policy and (2) the creation of a strategic implementation plan for the updated STI Policy, inclusive of an M&E framework. MINEDUC and NCST, in partnership with UNECA, will support these processes. The strategy formulation process, specifically, will involve a cross-cutting stakeholder engagement activity aimed at garnering concrete insights on three essential ingredients: (1) priorities for action; (2) incentives to encourage action by various stakeholders; and (3) specific, achievable targets for progress. To the extent possible, the strategy formulation process will tap into existing communities of practice, and will utilize existing mechanisms for stakeholder convenings to collect feedback. The partners expect the policy update and strategy formulation process to conclude in early 2014.

Photo: Farmland in rural Rwanda; Credit: The Global Knowledge Initiative

"Through embarking on a concerted effort to build science, technology and innovation capacity, Rwanda will greatly enhance her prospects of achieving growth, poverty reduction, wealth creation, and export diversification."

-- Hon. Vincent Biruta
Minister of Education

Appendices

I. Interview Protocol

The interview protocol below was used with respondents across government, industry, academia, and civil society. It was administered in late April and early May 2013. The protocol was modified slightly for different stakeholder groups.

General Questions

(1)   Please write your name and institutional affiliation
(2)   In 1-2 sentences, please describe your general responsibilities.
(3)   Are you familiar with Rwanda's STI policy? What do you know about the policy?
(4)   Is your work influenced / directed by the STI Policy? If yes, how?
- If in specific sector: Does the STI Policy influence decision-making in X sector? If so, how does it influence decision-making (either now or previously)?

(5)   With regard to STI Policy, what has been the most effective government reform undertaken since 2005? (contingent on question 4 answer)
- If in a specific sector: Either sector reform or outside of sector

(6)   What STI-based reform are you still waiting on/has not yet been implemented?
- If in a specific sector: Either list a sector-specific reform or another reform

(7)   How could the Government of Rwanda better utilize STI to achieve Vision 2020?

4 Pillars of STI Policy (Knowledge Acquisition, Creation, Transfer and Innovation Culture)

Questions for interviewee if NOT representing a specific sector

(8)   Acquiring knowledge is a key priority of the STI Policy. Can you give me an example of how you've seen this policy priority take shape?
- Activities undertaken to help people acquire knowledge (Sensitizing and Training)
- Challenges that have held back Knowledge Acquisition

(9)   Same for Knowledge Creation (Perform research inclusive of the training, investment and equipment to do it)
(10)   Same for Knowledge Transfer (Create connections to get research/technology to where it is needed (i.e., industry/community))
(11)   Same for Cultivating an Innovation Culture (Create partnerships with private sector)

Additional questions if interviewee represents a specific sector…

    (13)   In (fill in individual's sector) sector, what are the main mechanisms for acquiring knowledge (Sensitizing and Training)? Since 2005, what have been the major accomplishments in acquiring knowledge? What challenges do you still face?

    (14)   Same for Knowledge Creation (Perform research inclusive of the training, investment and equipment to do it)

    (15)   Same for Knowledge Transfer (Create connections to get research/technology to where it is needed (i.e., industry/community))

    (16)   Same for Cultivating an Innovation Culture (Create partnerships with private sector)

Government Reform Questions

    (17)   What is the status of X initiative / project? (Mention a few specific initiatives pertinent to the interviewees sector/institution that would seemingly connect to the STI Policy)

    (18)   In what way(s), if any, does the National STI Policy bear on this initiative / project?

    (19)   Who else is instrumental in implementing this initiative / project?

II. Survey Protocol & Survey Results

In early-mid May 2013 the review team developed and implemented a survey on attitudes toward STI and development. One hundred and seventy eight people participated, and were chosen using a mix of quota and judgment samples (a sample aimed at providing "quotas" of different sectors and based on author judgment). Results do not represent the people of Rwanda or — insofar as the survey was largely conducted in Kigali — urban populations. Rather, the survey provides a rough picture of some groups' attitudes toward STI and development. Below, find the survey questions asked. Average answers elicited follow each question.

Survey on Science, Technology, and Innovation in Rwanda

This survey is designed to help the Rwanda Ministry of Education and the Global Knowledge Initiative analyze Rwanda's National Science, Technology and Innovation Policy. Your answers will help us analyze this policy's impact on the entrepreneurs and workers that support Rwanda's economy. By taking this survey you consent to allow the Global Knowledge Initiative to use your responses in their analysis. Your responses will be used anonymously, however. ***NOTE: The content below includes data on responses elicited to the questions asked and the information solicited.***

Please write your age:

Mean age: 34.8 years
Range: 21-62

Sex: (Circle one)

68% Male
32% Female

What do you do for a living? (fill in)

Top 5 jobs:
  i. Farmer (24 respondents)
  ii. Teacher (23 respondents)
  iii. Construction worker (18 respondents)
  iv. Businessman/woman (10 respondents)
  v. Electrician (10 respondents)

Respondents by sector

Legend:
- Trades
- Agriculture
- Education
- Construction
- Sales/business
- Mining
- Student
- Personal services
- Security
- Financial services
- Government/NGO

Pie chart values:
- Trades 20%
- Agriculture 13%
- Education 13%
- Construction 10%
- Sales/business 8%
- Mining 6%
- Student 6%
- Personal services 5%
- Security 5%
- Financial services 4%
- Government/NGO 4%
- Other 6%
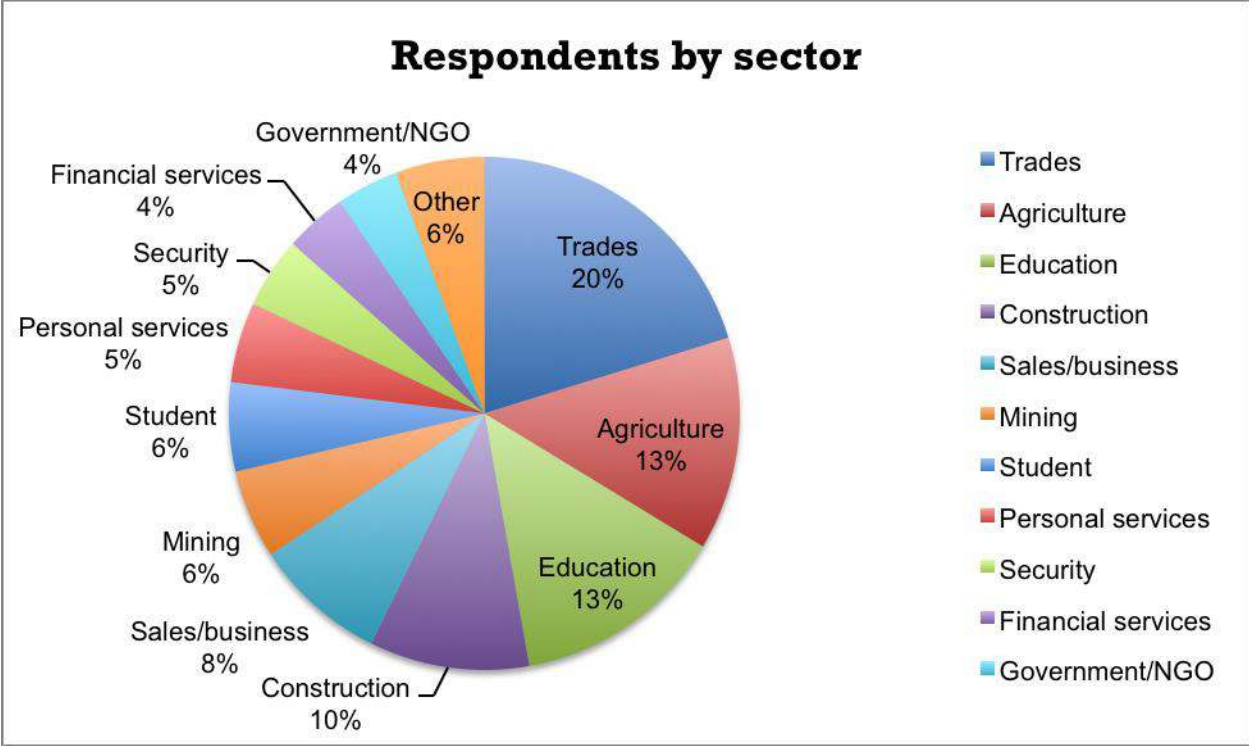
1. **What is your highest level of education? (Circle one)**
   - i. Never went to school (6.18%)
   - ii. Primary school (22.5%)
   - iii. Post primary TVET (10.1%)
   - iv. Some secondary school (13.5%)
   - v. Graduated secondary school (13.4%)
   - vi. Some university (11.2%)
   - vii. Graduated university (19.1%)
   - viii. Attended graduate school (5.1%)

2. **Has your family's life improved in the last five years? (Circle one)**
   - i. Got a lot worse (2.3%)
   - ii. Got somewhat worse (4.6%)
   - iii. Stayed the same (5.7%)
   - iv. Got a little better (69.3%)
   - v. Got much better 32 (18.2%)

Respondents who answered that life improved in some way or another equaled around 87.5% vs. those who thought things got worse/a lot worse at around 8.9%

3. **If you answered "Got a little better" or "Got much better" to what do you attribute this improvement? (Circle one)**
   - i. Better access to training/education (20.6%)
   - ii. Economic development in Rwanda (21.2%)
   - iii. Better access to technology (3.64%)
   - iv. Government programs (33.9%)

v. Better access to information/knowledge needed to solve problems (3%)
vi. Other _____ (17.6%)

Other answers: 27 respondents said that their personal efforts made things improve; 1 said government leadership improved things; another said that improvements in security made things improve.

4. **What challenges do you face in accessing technology or equipment to help with your work/business? (Circle one)**
    i. Cannot afford the technology/equipment I need (60%)
    ii. I am not certain of what technology/equipment would help me with my work/business (25.3%)
    iii. The technology/equipment available on the local market is not relevant to my needs (12.7%)
    iv. Other (please specify) _____ (2%)

5. **Since completing your highest level of education, have you ever received training from the following organizations when you need training or want to learn new skills to help you with your work/business? (Circle one)**
    i. Universities (10.8%)
    ii. Government (16.9%)
    iii. Private sector (23.7%)
    iv. Associations (such as a Cooperative, the Private Sector Federation, or another type of membership organization) (36.5%)
    v. Other (please specify) _____ (12.2%)

Other answers: 8 said that they received training from their employer; 5 said they received training from a colleague; 2 said friends, 2 said NGOs.

6. **What challenges do you face in accessing training to increase skills to support your work/business? (Circle one)**
    i. Cannot afford to access training opportunities (59%)
    ii. Training opportunities offered are not relevant to my needs (12.1%)
    iii. Training opportunities are too far away for me to reach them (24.1%)
    iv. Other (please specify) _____ (4.8%)

7. **When you need advice or answers to questions that can help your work/business, to whom do you turn? (Circle one)**
    i. Universities (9.2%)
    ii. Government (15.5%)
    iii. Private sector (24.1%)
    iv. Associations (such as a Cooperative, the Private Sector Federation, or another type of membership organization) (29.9%)
    v. Church or religious organization (4.6%)
    vi. Non Governmental Organization (NGO) (4%)
    vii. Other (please specify) _____ (12.6%)

Other answers: 9 said employers/supervisor; 8 said colleagues; 3 said friends; 1 said spouse.

8. **What challenges do you face in accessing advice or answers to questions that could help your work/business? (Circle one)**
    i. I am not certain of who would help me with my work/business questions (28.4%)
    ii. Cannot afford the advice I need (50%)
    iii. The advice available locally is not relevant to my needs (18.5%)
    iv. Other (please specify) _____ (3.1%)

9. **How many children do you have in school? (Circle)**
    i. None (21%)
    ii. 1 (22.2%)
    iii. 2 (29%)
    iv. 3 (21%)
    v. 4 (3.4%)
    vi. 5 or more (3.4%)

10. **If one or more, have schools improved or gotten worse in the last five years? (Circle one)**
    i. Gotten much worse (8.2%)
    ii. Gotten a little worse (28.3%)
    iii. Stayed the same (8.2%)
    iv. Gotten a little better (30.8%)
    v. Gotten much better (13.8%)
    vi. Don't know (10.7%)

The individuals who thought that schools improved a little bit or a lot make up 44.6% of respondents whereas the combined respondents that thought schools got a little worse/a lot worse made up 36.5% of respondents.

11. **Do you think the science and math classes your children are taking will prepare them to be successful? (Circle one)**
    i. Strongly disagree (1.9%)
    ii. Disagree (5%)
    iii. Not sure (34%)
    iv. Agree (37.7%)
    v. Strongly agree (21.4%)

The individuals who agreed or strongly agreed that science and math classes will prepare their children to be successful made up 59.1% of responses, while those who disagreed or strongly disagreed made up 6.9% of respondents. A full 34% were unsure whether science and math classes would help their children be successful.

12. **What change (positive or negative) has made the biggest difference for your work/business in the past five years?**

    The most common, general answers to this question (aggregated by type of answer) were:
    i. Government policies/programs (17%)
    ii. Technology (12%)

     iii. Education/training (11%)
     iv. Infrastructure (11%)
     v. Improvements in security (11%)

Individuals who did not know, or who answered with responses that did not fit with other common answers made up 23% of responses. See graph below for more information.

What change has made the biggest difference for your work in the past 5 years?

- Other/Don't know
- Gov't Policies
- Technology
- Training
- Infrastructure
- Security
- Education got worse
- Market conditions
- Social Development
- No response

Market conditions 3%
Social Development 2%
No response 6%
Education got worse 4%
Security 11%
Infrastructure 11%
Training 11%
Technology 12%
Gov't Policies 17%
Other/Don't know 23%

13. What is one thing that the Rwandan government could do to help you improve your work/business?

The most common, general answers to this question (aggregated by type of answer) were:
     i. Education and training (48%)
     ii. Technology and equipment (12%)
     iii. Infrastructure (12%)
     iv. Improve government policies/programs (9%)
     v. Improvements in security (7%)

See below for additional detail.

What could gov't do to improve your work/ business?

Legend:
- Training & Education — 48%
- Infrastructure — 12%
- Tech & Equipment — 12%
- Government policies — 9%
- Security — 7%
- No response — 4%
- Other — 8%
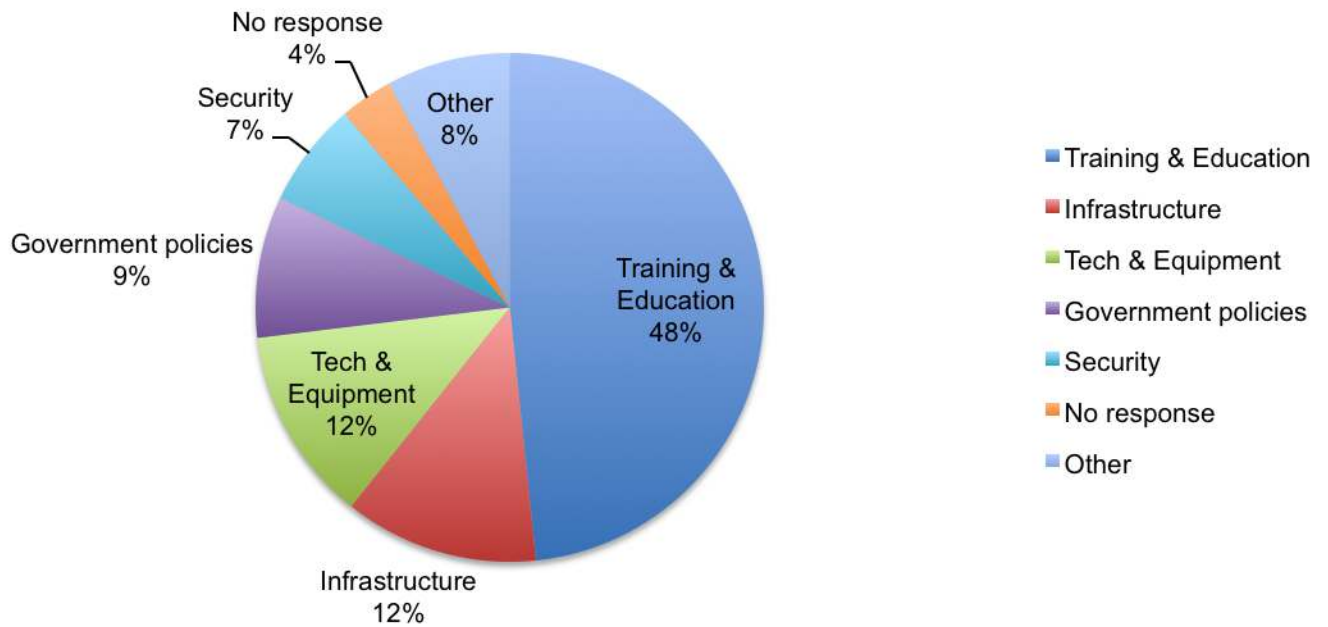
III. Experts Consulted

The review team would like to thank those individuals who gave of their time and expertise both for formal interviews and informal conversations. A list of experts consulted follows.

Sano Anselme, Director of Planning and Development, KIST

Elias Baingana, Budget Director, Ministry of Finance

H. Dharmarajan, CEO, Sulfo

Kimenyi Dickson, Engineer, Self-employed

Rudy Fernandez, CEO, Manumetal

Daphrose Gahakwa, Deputy Director General, Rwanda Agricultural Board

Marie-Christine Gasingirwa, Acting Rector, KIST (now DSTR Dir. Gen.)

Ignace Gatare, Director General, National Science and Technology Commission

Fabian Habimana, Director of Science Unit, Ministry of Education

Innocent Hagirimana, Head of Road Network Planning, Rwanda Transportation Development Authority

Michael Hughes, Advisor to Minister of Education, Ministry of Education

Chantal Kabagabo, Acting Rector, Kigali Health Institute

Jeffrey Kayonga, Vice President of the ICT Chamber, Private Sector Federation

Leopold Mbereyaho, Dean of the Faculty of Engineering, KIST

Sylvie Mboyo, Director of ICTs, KIST

Fred Mugisha, Director of Policy Planning, Higher Education Commission

Robert Muhize, Director of Manufacturing, Rwanda Development Board

Immaculee Mukabayire, Director, Center for Innovation and Technology Transfer, KIST, and her staff

Odette Mukabayire, Former Director General, National Reference Laboratory

Rose Mukankomeje, Director General, Rwanda Environmental Management Authority

Papias Musafiri, Acting Rector, School of Finance and Business

Albert Mutisa, Director of Science and Technology, UNESCO Rwanda

Hannington Namara, CEO, Private Sector Federation

Jean Chrysostome Ngabitsinze, Lecturer, NUR

Etienne Ntagwirumugara, Head of Electrical and Electronics Engineering Department, KIST

Alex Ruzibukira, Director General of Industry Development, Ministry of Trade and Industry

Molly Rwigamba, Attorney, RR Associates & Co Advocates

Bonfils Safari, Director of Quality, NUR

Jean Bosco Shema, Assistant Vice Rector in Charge of Administration and Finance, NUR

Remy Twiringiyimana, Acting Director General of Directorate of Science, Technology and Research, Ministry of Education

Individuals consulted for survey

In developing this analysis, the review team also anonymously surveyed 178 individuals throughout Rwanda's private and public sector. These interviews largely took place in Kigali. GKI and the in-country consultant Jean-Paul Safari chose survey targets so as to get a cross section of Rwanda's citizenry (this was done by visiting specific firms, but also through using less targeted methods such as meeting individuals coming off of public buses).

Interviewees cut across sectors, occupations, and education levels. The top occupations were: farmer, teacher, construction worker, businessman/woman, and electrician. The average age was 38, with a range of 21-62. The survey does not represent a random sample, and is skewed urban, male, and educated (most people had at least attended secondary school, with nearly 20 percent university graduates). However, it provides a good cross-cut of Rwanda's professional class, with some representation of the more than 80 percent of Rwandans working in agriculture.

IV. Grid of Policy Priorities and Proposed Reforms

The following table presents the specific reforms and priorities highlighted in the STI Policy. The reforms called for in the four pillars of the policy, as well as those detailed in the public reform sections (public sector reforms, S&T outreach, and implementation incentives). The priorities are presented as invitations for action, with HMW standing for "How might we…?"

Policy Pillar-Reforms Matrix (HMW = How Might We?)				
STI Policy Pillars	**Knowledge Acquisition** • HMW cultivate interest in Science and Technology? • HMW retain interest in S&T? • HMW train competent artisans to give high quality support to the development needs of Rwanda? • HMW train high level technicians to give high quality support to the development needs of Rwanda? • HMW offer high level theoretical and practical training for medical practitioners, technologists in various fields, agriculturalists, scientists, engineers, doctors, etc.	**Knowledge Creation** • HMW establish a National Council / Commission for STI to direct and guide the national plan of research? • HMW invest in training and development of international research partnerships to meet the development needs of Rwanda? • HMW equip research institutions? • HMW provide high level theoretical and practical training to produce high caliber scientists, engineers, doctors, etc?	**Knowledge Transfer** • HMW ensure widespread access to latest technology? • HMW establish links between research and technological development and the many and varied needs of industry, economy, and community, including technological hubs? • HMW establish Technology Consultation Centers? • HMW establish Demonstration Units? • HMW establish S&T Parks?	**Innovation Culture** • HMW establish business enterprise centers nationally, especially with technological institutions? • HMW establish District Innovation Centers? • HMW encourage private sector partnership as a key part of every sector?

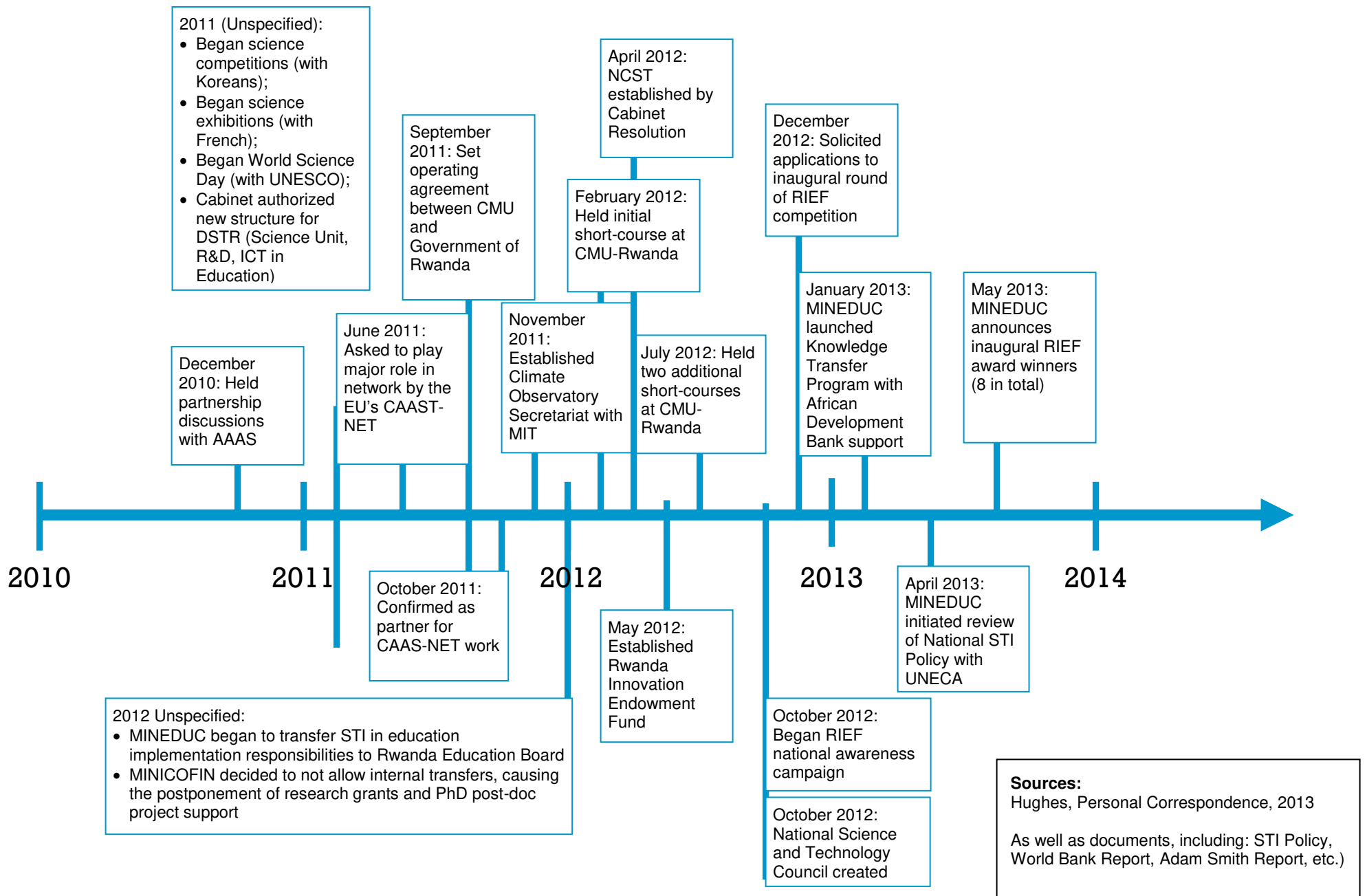| Public Sector Reforms | • HMW establish a core of well-qualified and competent S&T personnel in each ministry and throughout each economic sector?
• HMW empower women to fully participate in S&T development and management?
• HMW prioritize procurement and use of appropriate technologies, products, and services intended for use in schools in training, re-training, and skills upgrading?
• HMW encourage teaching and introduce experiments both in and after school?
• HMW strengthen national capacity in assessment of skill levels, achievements, technical qualifications, and to establish and monitor standards? | • HMW evolve sound and conducive public policy & appropriate legislation to generate new competitive products, services, and intellectual properties?
• HMW encourage research activities?
• HMW create an effective intellectual property management framework in S&T R&D institutions and firms?
• HMW create a legal framework to protect S&T intellectual property rights? | • HMW facilitate the use, advancement, & integration of science, math, communication, informatics, & computer technologies in industry, commerce & education?
• HMW ensure S&T is fully integrated into national and sectoral policies and across the education system?
• HMW promote sound and environmentally friendly technologies in industry and commerce?
• HMW take measures to promote and preserve Rwanda's rich culture and heritage, its fragile economy, environment, indigenous and traditional technologies, and community-based knowledge systems?
• HMW establish and operate an up-to-date S&T information exchange?
• HMW ensure provision of up-to-date technical advice?
• HMW ensure provision of up-to-date technical S&T extension services?
• HMW ensure business support?
• HMW ensure maintenance of a critical core of technical competencies in country? | • HMW evolve sound and conducive public policy and appropriate legislation to encourage national capacity to innovate?
• HMW advance indigenous small and medium sized enterprises? |
| S&T Outreach | • HMW generate local and community awareness in S&T? | | • HMW establish Technology Consultation Centres?
• HMW introduce S&T Parks, essentially to target rural communities?
• HMW advance inter-sectoral linkages? | • HMW set up Technology Incubators and Demonstration Units? |

Incentives for Implementation	• HMW ensure skills that are in high demand attract a special premium until the shortage is relieved? • HMW reward individuals and organizations for outstanding achievement in S&T? • HMW use the Science Olympiad (est. in March 2005) to motivate young people to excel in S&T studies?	• HMW exempt equipment and material imported for R&D activities from taxes? • HMW establish a National Research Fund?	• HMW ensure compensation packages to reward technical advisers through government recruitment and internal promotion policy?	• HMW provide tax incentives for resources committed by the private sector to S&T development, in particular R&D? • HMW promote innovative, entrepreneurial activities, with special emphasis on the rural areas (propose a national competition to link rural entrepreneurs with counterparts in the Diaspora)? • HMW incentivize commercialization of services/outputs from S&T institutions?

V. Timeline of Rwanda's STI Governance

November 2004: Issued Preparatory National Integrated Innovation Framework for Rwanda, CSIRO

July 2005: National STI Policy approved by the Rwandan Cabinet

March 2006: Ministry of Science, Technology and Scientific Research created in President's Office to lead implementation of STI Policy

April 2008: TVET Policy approved

March 2009: Signed S&T cooperation agreement with South Africa

September 2009: Adam Smith report on proposed S&T legal framework released

January 2007: Initiated Scoping Study for Support to the Government of Rwanda in the development of the Legal and Regulatory Framework

September 2004: Appointed Advisor in S&T

May 2005: Held National Science and Technology Conference in Butare

January 2008: World Bank released study entitled "Building STI Capacity in Rwanda"

July 2009: Released "Mapping S&T for Industrial Development" report in partnership with African Dev. Bank

2004   **2005**   **2006**   **2007**   **2008**   **2009**

September 2006: Released Aide Memoire "Developing a Needs Assessment and Action Plan for Science, Technology and Innovation Capacity Building"

June 2009: Responsibilities of Ministry of Science, Technology, and Scientific Research moved to Ministry of Education

July 2009: Drafted Cabinet Discussion Paper, Draft Organic Law, etc

2011 (Unspecified):
- Began science competitions (with Koreans);
- Began science exhibitions (with French);
- Began World Science Day (with UNESCO);
- Cabinet authorized new structure for DSTR (Science Unit, R&D, ICT in Education)

September 2011: Set operating agreement between CMU and Government of Rwanda

April 2012: NCST established by Cabinet Resolution

February 2012: Held initial short-course at CMU-Rwanda

December 2012: Solicited applications to inaugural round of RIEF competition

December 2010: Held partnership discussions with AAAS

June 2011: Asked to play major role in network by the EU's CAAST-NET

November 2011: Established Climate Observatory Secretariat with MIT

July 2012: Held two additional short-courses at CMU-Rwanda

January 2013: MINEDUC launched Knowledge Transfer Program with African Development Bank support

May 2013: MINEDUC announces inaugural RIEF award winners (8 in total)

2010   2011   2012   2013   2014

October 2011: Confirmed as partner for CAAS-NET work

May 2012: Established Rwanda Innovation Endowment Fund

April 2013: MINEDUC initiated review of National STI Policy with UNECA

2012 Unspecified:
- MINEDUC began to transfer STI in education implementation responsibilities to Rwanda Education Board
- MINICOFIN decided to not allow internal transfers, causing the postponement of research grants and PhD post-doc project support

October 2012: Began RIEF national awareness campaign

October 2012: National Science and Technology Council created

Sources:
Hughes, Personal Correspondence, 2013

As well as documents, including: STI Policy, World Bank Report, Adam Smith Report, etc.)

VI. Insights from the May 2013 Stakeholders Workshop

The May 2013 Stakeholders Workshop invited over 100 participants hailing from government, private sector, universities, and civil society to inform the STI Policy Review process. Namely, participants validated the proposed analytical framework for the review, which integrates the four STI pillars with reforms proposed in the policy. Participants also provided insight on the key STI achievements implemented since 2005, as well as the most pressing STI challenges that persist. The workshop resulted in a number of insights, highlighted in the numbered list below. The following pages provide an overview of the key STI achievements (presented in blue) and challenges (presented in green) as offered by workshop participants. Taken together, these insights provided a strong foundation upon which a comprehensive policy review built.

Key insights from workshop participants and speakers:

1. The relationship between policy development and implementing organizations relevant to STI needs to be clarified. Specifically, the relationship between and the specific roles of MINEDUC's Directorate of Science, Technology and Research and the newly created NCST should be clarified. This can be an explicit element of both the STI Policy Review and the follow-on strategy formulation processes.

2. Entrepreneurs are especially well placed to help realize the ambitions of the STI Policy. These individuals benefit from knowledge acquisition, knowledge creation, knowledge transfer, and the development and strengthening of Rwanda's innovation culture, each of which constitutes a pillar of the STI Policy. Rwandans need a strong enabling environment to allow them to move from being job seekers to job creators. STI offers key ingredients in making that aspiration achievable.

3. Achieving the highest level of socio-economic impact possible means knowing how best to scale interventions. We must set meaningful budgets, policy targets, and M&E frameworks for STI-related policies. By being specific about goals and targets—and ensuring accountability through M&E—we can better know what works, and what solutions are worth scaling. Lacking in the STI Policy and follow-on activities to date was a clear implementation plan with such targets. Remedying this oversight is an urgent priority and will position the broader STI stakeholder community for engagement and success.

4. An interactive exercise organized by GKI invited all 100 stakeholders to offer their own ideas as to the areas of achievement and challenge and opportunities ahead. Stakeholders present at the workshop noted that the STI Policy pillars of "Innovation Culture" (developing a culture of innovation) and "Knowledge Acquisition" (training and sensitizing on STI) were areas of high achievement. They specifically noted that growth in the Information and Communication Technology (ICT) sector and increased STI training and graduates speak to STI policy success.

5. In terms of challenges and opportunities looking forward, stakeholders offered a number of responses related to "Knowledge Creation."

6. Investments in STI need to better translate into commercialized products and services that contribute to Rwanda's economic growth. Research that is funded by the Government of Rwanda should be able to clearly demonstrate how it contributes to national development and specifically the achievement of EDPRS II and Vision 2020.

7. Research institutions and higher learning institutions must reach out and connect to communities and industries. They should not wait for those who need assistance to come to them, but should actively seek ways to meet community and industry needs. This should be undertaken in an organized, rather than an ad hoc, way. Direct outreach is the best way to assure knowledge transfer as noted in the policy.

8. Opportunities for regional harmonization on STI are key to development across the EAC. Specifically, the proposed Regional Council on Science and Technology with a proposed Secretariat in Rwanda could be an effective mechanism to harmonize regional approaches to STI.

9. The future of financial and political support to research and development is unclear. Both the levels of funding and the governance scheme through which specific organizations are charged with implementing policies related to STI should be more predictable. Rapid political change—in terms of administration and governance of STI—may hamper STI-related development.

10. Collaboration and communication are essential to the success of STI initiatives. Without stronger cross-sectoral communication, public-private-partnerships (PPPs) will be rare and/or weak. Structured collaboration has the capacity to boost output on STI across sectors, and help Rwanda meet its Vision 2020 targets.

Findings from the May 2, 2013, Workshop: Opinions on Key STI Achievement Since 2005

Pillar I: Knowledge Acquisition

- One Laptop per Child Program in primary schools (5 responses)
- Specialized science and technology institutions set up (2 responses)
- Putting in place basic facilities (2 responses)
- More students enrolling in science options especially girls (5 responses)
- More science and technology in universities (3 responses)
- Presidential scholarships for outstanding students (2 responses)
- More graduates in science and technology: BSc, MSc and PhDs
- Technical and vocational education and training centers (TVET) created (3 responses)
- ICTs in Education (4 responses)
- Carnegie Mellon University – Rwanda established (3 responses)

Pillar II: Knowledge Creation

- Linking Rwanda Higher Learning Institutions with international organizations (2 responses)
- Training scientists increased (3 responses)
- Increased publications (3 responses)
- Science and Technology has promoted research in higher learning institutions (2 responses)
- National Research Fund was established (2 responses)
- More participation in R&D at individual and institutional levels (2 responses)
- Research has been promoted in higher learning institutions
- Improved quality of research

Cross-Pillar Findings

- Information Communication Technologies (15 responses)
- ICTs in local government (2 responses)
- ICTs in health (4 responses)
- Improvement in water infrastructure such as water supply systems (2 responses)
- Establishment of the National Science and Technology Commission (2 responses)
- ICTs in socioeconomic development (3 responses)
- One cow per poor family (2 responses)
- GIS to improve land management
- Telecom companies involved in ICT upgrading (2 responses)
- Quicker service in local government (2 responses)
- NICI National ICT Policy and Strategy (2 responses)

Pillar III: Knowledge Transfer

- Center for Innovation and Technology Transfer (CITT) developed by Kigali Institute of Science and Technology (2 responses)
- Fiber Optic cable put in place (5 responses)
- KLab developed (2 responses)
- Rwandan higher learning institutions have linked with international organizations
- Opportunities in local manufacturing
- Rwanda Development Board/PSF ICT Chamber
- Creation of innovation centers

Pillar IV: Innovation Culture

- Innovation centers (3 responses)
- Rwanda Innovation Endowment Fund (5 responses)
- Entrepreneurial culture taking root in many higher learning institutions (2 responses)
- Innovation culture is at an advanced stage
- Many Rwandan websites with local content – news, entertainment, etc.
- Easy communication of sellers to markets through e-Soko
- Entrepreneurship development at Kigali Institute of Science and Technology

PILLAR I: KNOWLEDGE ACQUISITION

What are the achievements related to Knowledge Acquisition since 2005? Such achievements would include those pertinent to training. Responses below indicate a workshop participant's belief that of all achievements since 2005, those listed are the most significant for this pillar.

- One Laptop per Child Program
- Use of e-learning
- New options at KIST
- Increase in practical application in HLI and secondary school
- Introduction of science experiments in secondary school exams
- New graduate programs in ICT
- Information Communication Technologies in Education (4 responses)
- Increase in number of scientists and engineers
- Training on equipment used for research
- Carnegie Mellon University – Rwanda established (3 responses)
- Science education at secondary school level

PILLAR II: KNOWLEDGE CREATION

What are the achievements related to Knowledge Creation since 2005? Such achievements would include those pertinent to research. Responses below indicate a workshop participant's belief that of all achievements since 2005, those listed are the most significant for this pillar.

- Linking Rwanda Higher Learning Institutions with international organizations (2 responses)
- Training scientists increased (3 responses)
- Increased publications (3 responses)
- Science and technology has promoted research in higher learning institutions (2 responses)
- National Research Fund was established (2 responses)
- More participation in R&D at individual and institutional levels (2 responses)
- Research has been promoted in higher learning institutions
- Improved quality of research

PILLAR III: KNOWLEDGE TRANSFER

What are the achievements related to Knowledge Transfer since 2005? Such achievements would include those pertinent to creating links between research/ technology development and the needs of industry, market, and society. Responses below indicate a workshop participant's belief that of all achievements since 2005, those listed are the most significant for this pillar.

- Center for Innovation and Technology Transfer (CITT) developed by KIST (2 responses)
- Fiber Optic cable put in place (5 responses)
- KLab developed (2 responses)
- Rwandan higher learning institutions have linked with international organizations
- Opportunities in local manufacturing
- Rwanda Development Board/PSF ICT Chamber
- Creation of innovation centers

PILLAR IV: INNOVATION CULTURE

What are the achievements related to Innovation Culture since 2005? Such achievements would include those related to connecting to private sector and imbuing a culture geared toward commercialization. Responses below indicate a workshop participant's belief that of all achievements since 2005, those listed are the most significant for this pillar.

- Innovation centers (3 responses)
- Rwanda Innovation Endowment Fund (5 responses)
- Entrepreneurial culture taking root in many higher learning institutions (2 responses)
- Innovation culture is at an advanced stage
- Many Rwandan websites with local content – news, entertainment, etc.
- Easy communication of sellers to markets through e-Soko
- Entrepreneurship development at KIST

OTHER ACHIEVEMENTS / INTEGRATED SUCCESSES

What are the achievements noted by respondents as the greatest success since 2005 that cut across the four policy pillars? Note: responses below also include those achievements that fall outside of the four policy pillars but were indicated by workshop participants as the most significant within STI.

- Information and Communication Technologies (15 responses)
- Information and Communication Technologies in local government (2 responses)
- Information and Communication Technologies in health (4 responses)
- Improvement in water infrastructure such as water supply systems (2 responses)
- Establishment of the National Science and Technology Commission (2 responses)
- Integration of Information and Communication Technologies in socioeconomic development (3 responses)
- One Cow per Family program (2 responses)
- GIS to improve land management
- Telecom companies involved in ICT upgrading (2 responses)
- Quicker service in local government (2 responses)
- NICI National ICT Policy and Strategy (2 responses)

Findings from the May 2, 2013, Workshop
Opinions on Key STI Challenges and Opportunities
Looking to the Future

Pillar I: Knowledge Acquisition

- Quantity and quality of equipment (4 responses)
- Number of graduates in science and technology is small (+ ICTs) (4 responses)
- Quality of Education through hands on and theory (5 responses)
- Government does not sufficiently sponsor higher education and this results in school dropout (2 responses)
- More overseas scholarships BSc, MSc and PhDs in science and technology (2 responses)
- Women do not access S&T services/education as much as men (3 responses)
- Students are not very knowledgeable - quality of education
- Training across different S&T areas
- Need to increase the number of students and researchers in S&T
- Highly qualified technicians (2 responses)
- Innovation among girls in schools (3 responses)
- Poor equipment for trainings students – need hands on learning

Pillar II: Knowledge Creation

- Research funding is an issue (5 responses)
- Weak international collaborations in science and technology (2 responses)
- Online research system to help researchers access previous research (2 responses)
- Decentralization of funding facilities to higher learning institutions (2 responses)
- Motivation to research, considering the heavy workload of academics (3 responses)
- Need connections between higher learning institutions and research institutions
- Need better equipped labs (3 responses)
- Motivation for publication
- Enhancement of research publication
- Need to develop knowledge on climate change/agriculture adaption
- Need research on natural resources (gas, minerals, water)

Cross-Pillar Findings

- Making the STI Policy relevant to EDPRS (5 responses)
- Increase access to electricity/local power generation (4 responses)
- Gendered access to S&T (3 responses)
- Putting to use available infrastructure/electricity (3 responses)
- Little knowledge on climate change (2 responses)
- Develop media programs that help the ordinary people take advantage of STI (2 responses)
- Inadequate funding (10 responses)
- S&T to tap into resources like methane gas, minerals and water (2 responses)

Pillar III: Knowledge Transfer

- Rural people do not have good access to appropriate technologies (2 responses)
- Financial resources to support knowledge transfer initiatives (2 responses)
- Need to sensitize people on usage and application
- Need correct and timely information dissemination
- STI policy should reach out to rural people
- Need to establish international linkages on STI
- Need knowledge transfer to local IT companies

Pillar IV: Innovation Culture

- Promotion of research culture among academics (2 responses)
- There is no awareness between key stakeholders (policy makers and implementers) (6 responses)
- Weak partnerships between academics and the industry (2 responses)
- Private public partnerships (2 responses)
- Good will of Rwandese and good governance is an opportunity
- Need development of ICT companies
- Lack of commercialization of knowledge developed through research (2 responses)
- Need to develop stronger networking and partnership

PILLAR I: KNOWLEDGE ACQUISITION

Looking to the future, what are the major challenges and successes with respect to training? Responses below indicate a workshop participant's belief that of all challenges and opportunities to seize going forward, those listed below are the most significant for this pillar.

- Quantity and quality of equipment (4 responses)
- Number of graduates in Science and technology is small (+ ICTs) (4 responses)
- Quality of Education through hands on and theory (5 responses)
- Government does not sufficiently sponsor higher education and this results in school dropout (2 responses)
- More overseas scholarships BSc, MSc and PhDs in science and technology (2 responses)
- Women do not access S&T services/education as much as men (3 responses)
- Students are not very knowledgeable - quality of education
- Training across different S&T areas
- Need to increase the number of students and researchers in S&T
- Highly qualified technicians (2 responses)
- Innovation among girls in schools (3 responses)
- Poor equipment for trainings students – need hands on learning

PILLAR II: KNOWLEDGE CREATION

Looking to the future, what are the major challenges and successes with respect to research and knowledge creation? Responses below indicate a workshop participant's belief that of all challenges and opportunities to seize going forward, those listed below are the most significant for this pillar.

- Research funding is an issue (5 responses)
- Weak international collaborations in science and technology (2 responses)
- Online research system to help researchers access previous research (2 responses)
- Decentralization of funding facilities to higher learning institutions (2 responses)
- Motivation to research, considering the heavy workload of academics (3 responses)
- Need connections between higher learning institutions and research institutions
- Need better equipped labs (3 responses)
- Motivation for publication
- Enhancement of research publication
- Need to develop knowledge on climate change/agriculture adaption
- Need research on natural resources (gas, minerals, water)

PILLAR III: KNOWLEDGE TRANSFER

Looking to the future, what are the major challenges and successes with respect creating links between research/technology development and the needs of industry, the market and society? Responses below indicate a workshop participant's belief that of all challenges and opportunities to seize going forward, those listed below are the most significant for this pillar.

- Rural people do not have good access to appropriate technologies (2 responses)
- Financial resources to support knowledge transfer initiatives (2 responses)
- Need to sensitize people on usage and application
- Need correct and timely information dissemination
- STI policy should reach out to rural people
- Need to establish international linkages on STI
- Need knowledge transfer to local IT companies

PILLAR IV: INNOVATION CULTURE

Looking to the future, what are the major challenges and successes with respect to connecting to private sector and imbuing a culture geared toward commercialization? Responses below indicate a workshop participant's belief that of all challenges and opportunities to seize going forward, those in this pillar are the most significant.

- Promotion of research culture among academics (2 responses)
- There is no awareness between key stakeholders (policy makers and implementers) (6 responses)
- Weak partnerships between academics and the industry (2 responses)
- Private public partnerships (2 responses)
- Good will of Rwandese and good governance is an opportunity
- Need development of ICT companies
- Lack of commercialization of knowledge developed through research (2 responses)
- Need to develop stronger networking and partnership

OTHER ACHIEVEMENTS / INTEGRATED SUCCESSES

Responses below indicate a workshop participant's belief that of all challenges and opportunities to seize going forward, those that cut across the four pillars or even fall outside of them are the most significant.
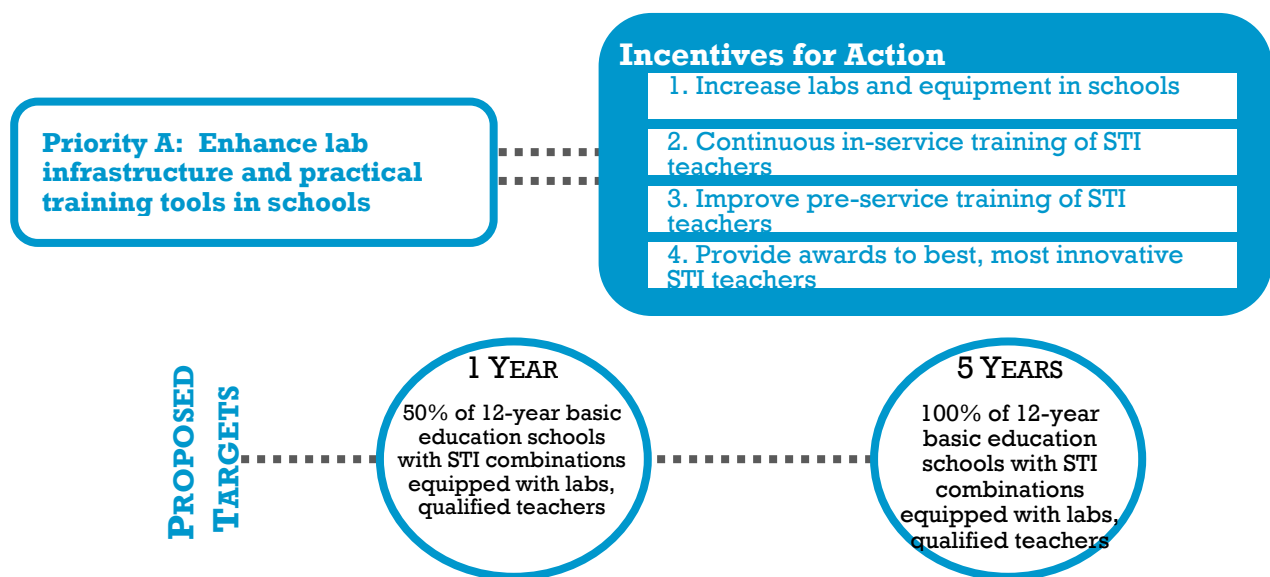
- Making the STI Policy relevant to Economic and Development and Poverty Reduction Strategy (5 responses)
- Increase access to electricity/local power generation (4 responses)
- Gendered access to science and technology (3 responses)
- Putting to use the available infrastructure/electricity (3 responses)
- Little knowledge on climate change (2 responses)
- Developing media programs that help the ordinary people take advantage of STI (2 responses)
- Opportunities: ICT Infrastructure
- Access to funding and grants
- Need more flexible procedures
- Need to create awareness of significance of ICT to national development
- Inadequate funding (10 responses)
- Science and technology t tap into resources like methane gas, minerals and water (2 responses)
- People do not know about the STI Policy
- Improved utilization and decreased cost of national broadband network
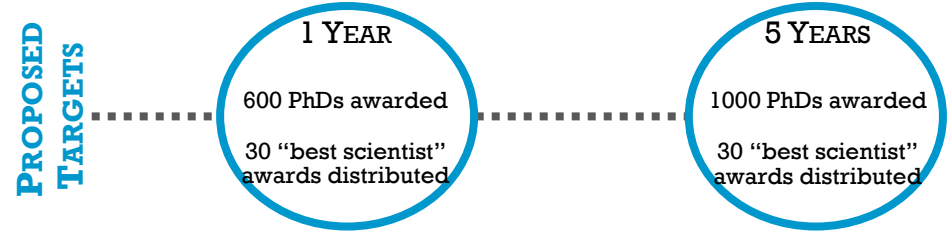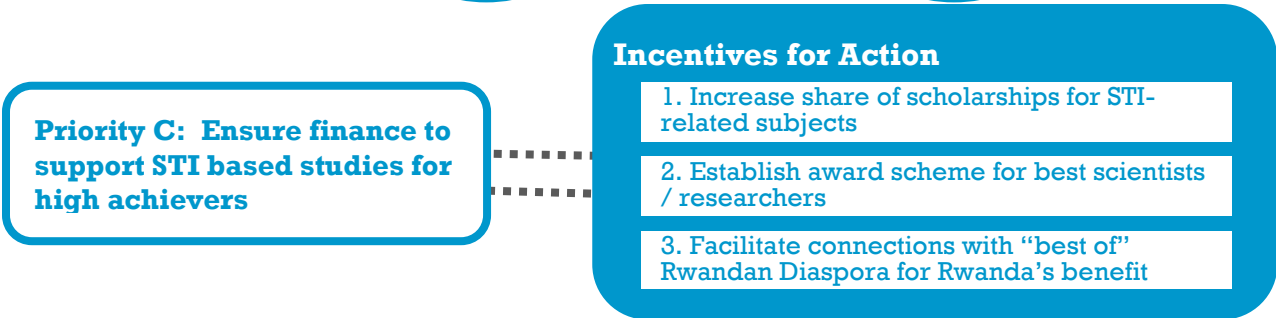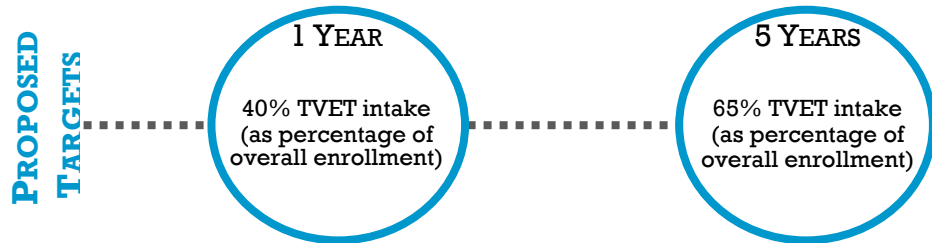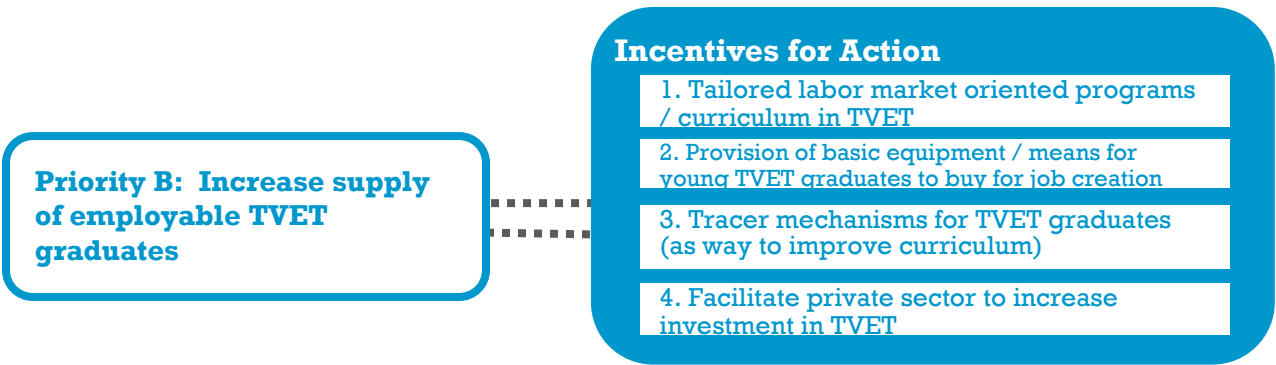- Roll out of "Last mile" connectivity throughout Rwanda

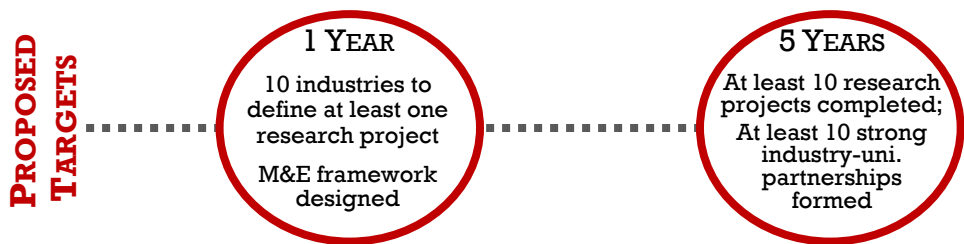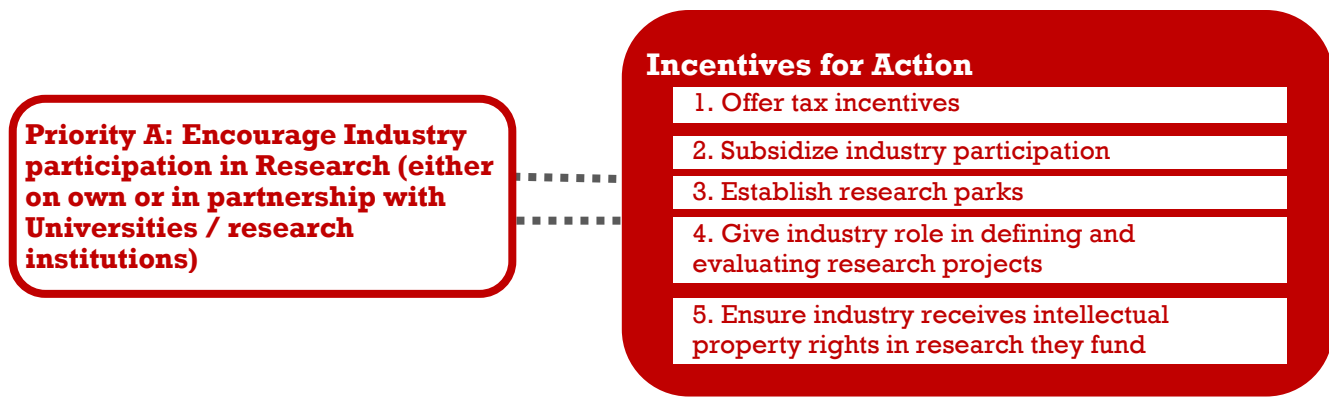# VII. Insights from June 2013 Validation Workshop

During the 20 June 2013 workshop designed to validate key findings of the STI Policy Review and kickoff the strategy formulation process, stakeholders identified three priority actions per capacity building pillar, for a total of twelve priorities identified. The stakeholders proceeded to identify incentives that might mobilize stakeholder action, and potential targets for progress on these priorities. The following diagrams provide an overview of the priorities, incentives, and targets for action as identified by the approximately 40 stakeholders that participated in the workshop. The STI Strategy Team (led by DSTR) aim to use this model for collecting feedback on priorities, incentives, and targets for action with a larger, more diverse group of stakeholders during strategy formulation.

Knowledge Acquisition: Stakeholder Feedback on Priorities, Incentives, and Targets for Action

Incentives for Action
1. Increase labs and equipment in schools
2. Continuous in-service training of STI teachers
3. Improve pre-service training of STI teachers
4. Provide awards to best, most innovative STI teachers

Priority A: Enhance lab infrastructure and practical training tools in schools

PROPOSED TARGETS

1 YEAR
50% of 12-year basic education schools with STI combinations equipped with labs, qualified teachers

5 YEARS
100% of 12-year basic education schools with STI combinations equipped with labs, qualified teachers

Priority B: Increase supply of employable TVET graduates

Incentives for Action

1. Tailored labor market oriented programs / curriculum in TVET
2. Provision of basic equipment / means for young TVET graduates to buy for job creation
3. Tracer mechanisms for TVET graduates (as way to improve curriculum)
4. Facilitate private sector to increase investment in TVET

PROPOSED TARGETS

1 YEAR

40% TVET intake (as percentage of overall enrollment)

5 YEARS

65% TVET intake (as percentage of overall enrollment)

Priority C: Ensure finance to support STI based studies for high achievers

Incentives for Action

1. Increase share of scholarships for STI-related subjects
2. Establish award scheme for best scientists / researchers
3. Facilitate connections with "best of" Rwandan Diaspora for Rwanda's benefit

PROPOSED TARGETS

1 YEAR

600 PhDs awarded

30 "best scientist" awards distributed

5 YEARS

1000 PhDs awarded

30 "best scientist" awards distributed

Knowledge Creation: Stakeholder Feedback on Priorities, Incentives, and Targets for Action

Priority A: Encourage Industry participation in Research (either on own or in partnership with Universities / research institutions)

Incentives for Action

1. Offer tax incentives
2. Subsidize industry participation
3. Establish research parks
4. Give industry role in defining and evaluating research projects
5. Ensure industry receives intellectual property rights in research they fund

PROPOSED TARGETS

1 YEAR

10 industries to define at least one research project

M&E framework designed

5 YEARS

At least 10 research projects completed;
At least 10 strong industry-uni. partnerships formed

Priority B: Define, implement research-specific problems involved in addressing high priority dev challenges

Incentives for Action

1. Research organization not identified with one specific sector
2. Create cross sector working groups to address specific national priorities on regular basis
3. Establish research networks aligned with national priorities
4. Create Department of Science, Technology, and Research empowered to coordinate
5. Maximize effective use of research facilities

PROPOSED TARGETS

1 YEAR
Coordinating framework for research established

Needs assessment to inform research priorities

5 YEARS
Strong research structure in place with cross-sector working groups and research networks coordinating priority research

Priority C: Develop high-level capacity in Research

Incentives for Action

1. Improve research facilities and infrastructure in higher learning institutions
2. Provide research scholarships
3. Facilitate North-South research partnerships
4. Hold research conferences in Rwanda
5. Offer sabbaticals for research
6. Establish National Academy of Sciences

PROPOSED TARGETS

1 YEAR
National Research Fund established

Staff development policy for research created

5 YEARS
At least 20 post-graduate programs

At least one North / South partnership established on each campus

Knowledge Transfer: Stakeholder Feedback on Priorities, Incentives, and Targets for Action

Priority A: Improve translation of research results into meaningful inputs for businesses and communities

Incentives for Action

1. Recognize excellence in Knowledge Transfer, such as through awards
2. Offer financial incentives, like fees
3. Run national showroom of top KT successes
4. Give entrepreneurs / communities role in setting research agenda

PROPOSED TARGETS

1 YEAR
Clear policy structure for KT established

Research proposals submitted by industry

5 YEARS
Growth in projects proposed by industry

Increase over baseline of university-industry partnerships by 50%

Priority B: Increase opportunities for student mentorship and industrial attachment

Incentives for Action

1. Tax incentives for companies that take on students

2. Government-provided insurance for students on attachment

3. Awards to companies that lead attachment effort

4. Certificates for students who complete attachment

PROPOSED TARGETS

1 YEAR
Success stories distributed
Website to advertise / recruit opportunities
50 MOUs between industry-HLI

5 YEARS
200 industry partnerships for attachment
80-90% post-secondary students placed in attachment

Priority C: Establish Innovation Consultancy, Research, and Development Centers at university campuses

Incentives for Action

1. Clear framework for consultancies

2. Clear budget allocated

3. Ability to overcome language barriers

4. Projects of national / industry priority linked to Center

PROPOSED TARGETS

1 YEAR
Clear strategic plan, including fundraising targets
Specific projects in place

5 YEARS
ICRD Centers established in each province
Research results published and distributed to beneficiaries

Innovation Culture: Stakeholder Feedback on Priorities, Incentives, and Targets for Action

Priority A: Take stock of current innovation / entrepreneurship initiatives to identify points of overlap and synergy

Incentives for Action

1. Host competition for innovative universities

2. Project-based partnerships

3. Catalogue of innovation support activities

PROPOSED TARGETS

1 YEAR
Annual inventory of innovative ventures piloted
Awareness of Rwandan innovations increased

5 YEARS
5 annual inventories of Rwandan innovations completed
Large-scale showcase of innovations

Priority B: Address structural barriers to innovation (e.g., high energy costs, heavy teaching loads, high tax rate on research grants)

Incentives for Action

1. Increased awareness of tax advantages

2. Decreased taxes on research grants

3. Decreased faculty teaching workload for researchers

4. Awards for saving energy

PROPOSED TARGETS

1 YEAR

Tax rebates for education, research implemented

Teaching load for university researchers decreased

5 YEARS

Effective, efficient accounting system put in place

Flexible procurement system available

Priority C: Encourage critical thinking, inquiry based learning, and creativity

Incentives for Action

1. Award for most learner-centered teachers

2. Training of trainers for boosting critical thinking skills

3. Highlight role model innovators

4. Support study innovation competitions

PROPOSED TARGETS

1 YEAR

Curriculum review to incorporate critical thinking completed

Award best "learning culture" companies

5 YEARS

Teachers in critical thinking certified

Improvements in enabling environment over baseline

VIII. Data Notes for Drivers

Below, find a summary of findings and sources informing "Key Drivers" on page 18.

1. **Create more private sector jobs**
   - **Target:** 200,000 new non-farm jobs created per year
     Assessment: Underperforming. 177,362 jobs were created in 2011-12.
     Source: EDPRS, EDPRS II

2. **Expand access to a revitalized TVET system**
   - **Potential Targets:**
     1- Percentage of TVET graduates employed after six months
     2- Proportion of employers satisfied with TVET graduates
     3- University graduates employed one year after
     Assessment: N/A. New priority areas; data not yet available.
     Source: EDPRS II

3. **Grow the economy**
   - **Target:** 8.1% annual economic growth rate (recently retargeted to 11.5%).
     Assessment: Better than target. Real GDP growth averaged 8.2% annual between 2008-2012, exceeding the original Vision 2020 targets. The target growth rate was recently elevated to 10.2% by 2017 and 11.5% by 2020.
     Source: EDPRS, EDPRS II

4. **Shift from agriculture-based to services economy**
   - **Target:** Agriculture falls to 25% of GDP by 2020 while services and industry rise to 55% and 20%, respectively
     Assessment: On target. In 2012, GDP composition by sector was 33.3% agriculture, 13.9% industry, and 52.9% services (retargeted from 33/42/26%).
     Source: Vision 2020, CIA World Factbook
   - **Target:** Agricultural sector employment reduced from 80% to 70% of the workforce in 2012, and to 50% by 2020.
     Assessment: On target. EDPRS II reports that employment in agriculture in 2011/12 was 71.6%.
     Source: Vision 2020, EDPRS

5. **Expand access to ICTs**
   - **Target:** ICT penetration rate to reach 40% by 2012.
     Assessment: Better than target. The penetration rate was 44% in 2011/12
     Source: EDPRS, EDPRS II

6. **Cultivate youth as job creators as opposed to job seekers**
   - **Target:** Policy actions to support youth entrepreneurship and the use of savings and credit facilities
   - **Assessment:** On target. Youth are identified as a target area, but success in EDPRS was measured through policy actions rather than indicator targets. GoR has supported the establishment of Youth Cooperative Banks for Self Employment and Development (COOJAD) in seven Districts—membership increased from 1,700 to over 4,300, 61 youth associations were transformed into cooperatives, and loans have

been disbursed to 552 people. Government of Rwanda has also signed an MOU with the Guarantee Fund of the National Bank to facilitate credit access for entrepreneurial youth.
   - **Source:** EDPRS II
7. **Support opportunities for rural development**
   - **Potential Targets:**
     1- Percentage of households who rise out of extreme poverty
     2- Rural households with access to electricity
     3- Rural households with access to improved sanitation
   - **Assessment:** N/A. Need more data.
   - **Source:** EDPRS II
8. **Decrease income inequality**
   - **Target:** Reduce Gini coefficient to 0.40 by 2010 and 0.35 by 2020.
   - **Assessment:** Underperforming. According to EDPRS, Rwanda's Gini coefficient was 0.47 in 2000 and rose to 0.51 in 2006. The most recent data from the World Bank has the Gini coefficient remaining at 0.51 in 2011.
   - **Source:** Vision 2020, World Bank World Development Indicators
9. **Orient universities toward labor market needs**
   - **Target:** Employers satisfied with university graduates. Baseline of 79.4% in 2010, target is >90% by 2015.
   - **Assessment:** N/A. Need more data.
   - **Source:** EDPRS II
10. **Coordinate donor support**
   - **Target:** Implement Sector Wide Approaches (SWAp) for critical sectors.
   - **Assessment:** On target. Rwanda has Sector Wide Approaches for the agriculture, health, energy and electricity, and education sectors.
   - **Source:** ESMAP
11. **Prioritize District-level service provision**
   - **Target:** 85% of districts achieving 80% of their service delivery and sustainable local development targets in 2012, rising to 95% by 2017.
   - **Assessment:** Underperforming. Only 75% of districts achieved 80% of their targets in 2012.
   - **Source:** EDPRS, EDPRS II

IX. References

Ashden. (n.d.). "KIST, Rwanda: Large-scale biogas for sanitation." *Ashden Awards*. Retrieved from: http://www.ashden.org/winners/kist05

BDF. (2011). *Guarantee Fund*. Business Development Fund. Retrieved from: http://www.bdf.rw/guarantee_fund.php

Brar, S., Farley, S., Hawkins, R., Wagner, C. (2011). *Science, Technology, and Innovation in Uganda*. The World Bank: Washington, DC.

Business Development Services . (2011). *Services*. Retrieved from Business Development Services : http://www.bdf.rw/services.php

Carnegie Mellon University. (n.d.). "About Carnegie Mellon University in Rwanda." *Carnegie Mellon University, Rwanda*. Retrieved from: http://www.cmu.edu/rwanda/about-cmur/index.html

CIA. (2013). "Rwanda." *The World Factbook*. Central Intelligence Agency. Retrieved from: https://www.cia.gov/library/publications/the-world-factbook/geos/rw.html

ESMAP. (2012). *Rwanda Extending Access to Energy*. The World Bank: Washington, DC.

Global Knowledge Initiative. (2011). *A Regional Exploration of Pathways Toward Harmonization of Math & Science Curriculum in the East African Community*. The World Bank: Washington, DC.

Global Knowledge Initiative, (January 2012). *LINK Analysis Rwanda; Mapping Science, Technology and Innovaiton Resources to Tackle a Coffee Pest Challenge in the Land of 1000 Hills*. Washington, DC. http://dl.dropboxusercontent.com/u/14504483/GKI%20Full%20Book.pdf

Global Knowledge Initiative. (2013). *Rwanda STI Policy Review Stakeholder Interviews*. Conducted in Kigali Rwanda. Interview details available upon request.

Government of Rwanda, *Education Sector Strategic Plan 2010-2015,* (2010) http://planipolis.iiep.unesco.org/upload/Rwanda/RwandaESSP20102015.pdf

Government of Rwanda. (2012). "Rwanda Opens Center to Increase Innovation and Protect Intellectual Property Rights." *All Africa*. Retrieved from: http://allafrica.com/stories/201303270083.html

Government of Rwanda. (2009). *Vision 2020*. Retrieved from: http://www.minecofin.gov.rw/webfm_send/1700

Ishimwe, T. (2013). "National Gene Bank Moves to Ensure Food Security." *The New Times*. Retrieved from: http://www.newtimes.co.rw/news/index.php?i=15265&a=63744

JICA. (2011). "Strengthening Education and Training in Science and Technology." *JICA Rwanda*. Retrieved from: http://www.jica.go.jp/rwanda/english/office/about/about_01.html

K Lab . (2012). *What is KLab?* Retrieved from K Lab : http://klab.rw/public/about

KIST. (2011). "Research Policy and Operational Procedures." KIST: Kigali.

KIST. (2013). *Technology and Business Incubation Facility*. Kigali Institute of Technology. Retrieved from: http://www.kist.ac.rw/tbif/

KIST. (2013). University budget figures. Delivered to GKI by university staff.

Kwizera, C. (2010). "Rwanda: 200 Girls to Be Sponsored in Science and Technology". The New Times. Retrieved from: http://allafrica.com/stories/201008230100.html

McGonegal, J. (2013). "A Woman, A Mountain, A Quest to Map Climate Change." *Slice of MIT*. Retrieved from: http://alum.mit.edu/pages/sliceofmit/2013/06/12/a-woman-a-mountain-a-quest-to-map-climate-change/.

MINECOFIN. (2008). National Budget of Rwanda. Delivered to GKI by Rwanda MINECOFIN.

MINECOFIN. (2012). National Budget of Rwanda. Delivered to GKI by Rwanda MINECOFIN.

MINICOM. (2012). *Hanga Umurimo Project,* Kigali, Rwanda.

MINICOM. (2013). **"MINICOM and JICA partners in "One Village One Product" program to revitalize SMEs"** *Ministry of Trade and Industry*. Retrieved from: http://www.gov.rw/MINICOMand-JICA-partners-in-One-Village-OneProduct-program-to-revitalize-SMEs?lang=rw

MINICOM. (n.d.). "SME's". *Ministry of Trade and Industry*. Retrieved from: http://www.minicom.gov.rw/?article96

MINEDUC. (2012). Rwanda Education Statistics. Delivered to GKI by Rwanda MINEDUC.

MINEDUC. (2012). *Rwanda Innovation Endowment Fund*. Rwanda Ministry of Education. Retrieved from: http://mineduc.gov.rw/rief/

MYICT. (2013). *Youth Empowerment for Global Opportunity*. Rwanda Ministry of Youth and ICT. Retrieved from: http://www.myict.gov.rw/youth/flagship-programmes/yego-youth-empowerment-for-global-opportunity/

The New Times. (2012). "TVET to Constitute 60%". *The New Times*. Retrieved from: http://www.newtimes.co.rw/news/views/article_print.php?i=14930&a=51264&icon=Print

Ngatungira. (2013). "Rwandan engineers launch umbrella body". *The Independent*. Retrieved from: http://www.independent.co.ug/rwanda-ed/rwanda/7742-rwandan-engineers-launch-umbrella-body

NUR. (n.d.). "Historical Background". *National University of Rwanda*. Retrieved from: http://www.nur.ac.rw/spip.php?article1

NUR. (2011). *NUR Revised Research Policy*. National University of Rwanda: Butare, Rwanda. Retrieved from: http://www.researchdirectorate.nur.ac.rw/IMG/pdf/2011_draft_REVISED_NUR_RESEARCH_POLICY_version1.pdf

NUR. (2013). University budget figures. Delivered to GKI by university staff.

PSF. (2012). *Business Development Services*. Retrieved from Private Sector Fenderation : http://www.psf.org.rw/about-us/services/business-development-services

RBC. (2013). *Rwanda Biomedical Center*. Retrieved from: http://www.rbc.gov.rw/

RDB. (2013). *Business Development Centers*. Retrieved from Rwanda Development Board: http://www.rdb.rw/departments/trade-and-manufacturing/business-development-centre/bdc-contacts.html

RDB. (2011). "RDB to launch Business Incubation Centre in Masaka on 26 May 2011." *Rwanda Development Board*. Retrieved from: http://www.rdb.rw/news-pages/news-details/article/rdb-to-launch-incubation-business-centre-in-masaka-on-26-may-2011.html

RDB. (2011). "Rwanda: Connected to the World." *Rwanda Development Board*. Retrieved from: http://www.rdb.rw/uploads/tx_sbdownloader/2011_ICT_brochure_RDB.pdf=

RTN. (n.d.). *Business Development Services*. Rwanda Telecentre Network. Retrieved from: http://www.rtnrwanda.org/index.php/en/2011-08-15-07-10-58/bdc

Sindayigaya, B. Samuel. (2010). *Statistical Information on Higher Learning Institutions in Rwanda*. National Council for Higher Education. Retrieved from: http://www.hec.gov.rw/IMG/pdf/STATISTICAL_INFORMATION_ON_HIGHER_LEANING_INSTITUTIONS_FOR_PUBLISH-2-2-2.pdf

SME Portal. (2012). *Hanga Umurimo Brochure*. Small and Medium Enterprise Portal. Retrieved from: http://www.smeportal.gov.rw/IMG/pdf/hanga_umurimo_brochure_english.pdf

STEPS. (2010). *A New Manifsto*. STEPS Centre: Sussex, UK. Retrieved from: http://www.anewmanifesto.org/manifesto_2010/

Thomson Reuters. (2013). "Web of Science." *Thomson Re uters*. Retrieved from: http://thomsonreuters.com/web-of-science/.

Umutara Polytechnic. (2011). "Research, Consultancy and Publication Policy." Umutara Polytechnic: Nyagatare, Rwanda. Retrieved from: http://www.umutarapolytech.ac.rw/docs/researchpolicy.pdf

USAID. (2013). "Rwanda: Education." United States Agency for International Development. Retrieved from: http://www.usaid.gov/rwanda/education

Watkins, A. Ehst, M. (2008). *Science, Technology, and Innovation, Capacity Building for Sustainable Growth and Poverty Reduction*. World Bank: Washington.

Watkins A. & Verma, A. (2008). *Building Science, Technology, and Innovation Capacity in Rwanda: Developing Practical Solutions to Practical Problems*. World Bank: Washington, DC.

WEF. (2012). *The Global Competitiveness Report 2012-2013*. World Economic Forum: Geneva.

WEF. (2010). *The Global Competitiveness Report 2010-2011*. World Economic Forum: Geneva.

William Davidson Institute. (2010). *Goldman Sachs 10,000 Women Entrepreneur Certificate Program*. Willian Davidsom Institute. Retrieved from: http://wdi.umich.edu/ee/activities/entrepreneurship-programs/goldman-sachs-10-000-women-initiative

World Bank. (2013). *World Development Indicators*. World Bank: Washington, DC. Retrieved from: http://data.worldbank.org/data-catalog/world-development-indicators