REPUBLIC OF RWANDA

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

ANALYSIS REPORT

RWANDA NATIONAL RESEARCH AND EXPERIMENTAL DEVELOPMENT (R&D) SURVEY FOR 2018/2019

October 2021

FOREWORD

The National Research and Experimental Development (R&D) is an important tool for monitoring the performance of the National System of Innovation. R&D is one of the key enablers and core pillars of the transformation of Rwanda into a knowledge-based and service-oriented economy needed to achieve the Vision 2050. In this regard, Rwanda is engaged in various strategic initiatives to strengthen her R&D Ecosystem, through for example the network of centers of excellence, R&D institutes and tech business centers. Furthermore, in June 2020, the parliament approved the national Science, Technology, and Innovation (STI) Policy that stipulates strategic objectives and policy actions that guide the interventions in science, technology, research and innovation towards becoming a knowledge-based economy.

In order to strategically leverage the existing efforts and increase the efficiency and socio-economic impact of previous, current and future R&D-related investments, there is a need for periodic collection of R&D statistics to support informed decision-making in both the public and private sectors. It is within this background that, The National Council for Science and Technology (NCST), as a public advisory national institution, with a mandate of providing informed and strategic policy recommendations and advice to the Government of Rwanda on issues pertaining to the development of Science, Technology, Research and Innovation (STRI); periodically collects and analyzes the R&D data. The findings facilitate the measurement and provision of policy advice to the Government on STRI policy implementation, policy targets and priorities.

In order to gauge the state, performance and impact of the various R&D investments, NCST conducted the Rwanda National Research and Experimental Development (R&D) Survey for the reference year 2018/2019, considering the previous survey of 2015/2016 as the baseline. The survey covers the four R&D-performing sectors in Rwanda, namely, the government, higher education, business enterprise and private non-profit sectors. This approach is followed in order to maintain consistency with the categorization of institutional sectors recommended by the Organization for Economic Cooperation and Development (OECD) in the Frascati Manual (OECD, 2015), which proposes standard practice for surveys on Research and Experimental Development.

The current analysis report presents aggregate statistics on key indicators for R&D performance such as expenditure, funding, human resources and output, which can be used to assess national progress and for international comparison. The survey established that the overall Gross Domestic Expenditure on R&D (GERD) increased from 0.66% of GDP in 2015/2016 to 0.69% of GDP in 2018/2019. This shows a good progress made but more efforts are still required to meet the national target of 1% of GDP recommended by the African Union. The GERD encompasses both intramural and extramural expenditures and is further presented by source and sector of performance: the Government Expenditure on R&D

(GOVERD), the Higher Education Expenditure on R&D (HERD), the Business Expenditure on R&D (BERD), and the Private-Non-Profit Expenditure on R&D (PNPERD).

The survey provides statistics on the respective sources and amounts of R&D funding which grossed to Rwf 68,601,617,986. Of this amount, the government funds contributed over half of the overall funding (58%), followed by foreign funds (24.6%), own funds (11.2%), and funds from firms (6.2%).

The survey establishes significant progress in human capital and impact of efforts put in place to address gaps between male and female R&D personnel. However, the country's human capital and research outputs need to increase so that our national system of innovation can contribute optimally to Rwanda's socio-economic development targets.

The Government continues to provide public funding that benefit the private sector by supporting partnerships between business, higher education institutions and public research institutions, to stimulate R&D intensity in the country. Public-Private sector collaboration needs to be strengthened in order to take advantage of the country's researcher base in a way that stimulates business R&D investment. There is a need to put in place policies to encourage companies to undertake R&D within the country.

The participation of respondents from the four institutional sectors in the R&D Survey is sincerely appreciated. Your efforts provide NCST with a critical evidence base for science, technology and innovation to play a transformative role in addressing the country's social-economic development challenges.

I thank you and look forward to your continued support and collaboration with future surveys and other NCST's efforts to strengthen the National System of Innovation.

Dr. Eugene Mutimura
Executive Secretary
National Council for Science and Technology (NCST)

ABBREVIATIONS AND ACRONYMS

BERD	Business Expenditure on R&D
FTE	Full-Time Equivalent
FORD	Field of R&D
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on R&D
GOVERD	Government Intramural Expenditure on R&D
HEC	Higher Education Council
HERD	Higher Education Expenditure on R&D
MINEDUC	Ministry of Education
NCST	National Council for Science and Technology
NGO	Non-Governmental Organizations
NISR	National Institute of Statistics of Rwanda
NIS	National Innovation System
NRIF	National Research and Innovation Fund
PNP	Private Non-Profit organizations
NST1	National Strategy for Transformation
OECD	Organisation for Economic Cooperation and Development
RDB	Rwanda Development Board
RGB	Rwanda Governance Board
RRA	Rwanda Revenue Authority
RWF	Rwandan Franc (Rwandan currency)
R&D	Research and Experimental Development
RF	Research Field
STI	Science, Technology and Innovation
STRI	Science, Technology, Research and Innovation
Vision 2050	Rwanda's Vision 2050

TECHNICAL TEAM

No	Names	Function
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6	Mr. Didier Gaga Rukorera	NISR, Survey Sampling Expert
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DEFINITION OF TERMS

The following definitions are adopted from the Frascati manual 2015 (OECD, 2015), which was the basis for this survey.

Applied research is original investigation undertaken in order to acquire new knowledge. It is directed primarily towards a specific practical aim or objective.

Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view.

BERD refers to business expenditure on research and experimental development.

Capital expenditure is the annual gross expenditure on fixed assets used repeatedly or continuously in the performance of R&D programmes for more than one year. Such expenditure is reported in full in the period in which it took place and is not registered as an element of depreciation. Capital expenditure includes expenditure on land, buildings, instruments and equipment.

Current expenditure is composed of labour costs of R&D personnel and other current costs used in R&D. Services and items (including equipment) used and consumed within one year are current expenditures. Annual fees or rents for the use of fixed assets are included in current expenditures.

Experimental development is systematic work, drawing on existing knowledge gained from research and/or practical experience, which is directed to producing new materials, products or devices, to installing new processes, systems or services, or to improving substantially those already produced or installed.

Full-time equivalent (FTE) refers to the number of hours (person-years of effort) spent on R&D activities.

FTE per 1 000 in total employment is the number of professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems, as well as in the management of these projects during a given year expressed as a proportion of 1,000 employed people. It is calculated by number of researchers during a given year divided by the total employed people and multiplied by 1 000.

Gross domestic product (GDP) is the total market value of all final goods and services produced in a country in a given year, equal to total consumer, investment and government spending, plus the value of exports, minus the value of imports.

Gross domestic expenditure on research and experimental development (GERD) covers all expenditures for R&D performed on national territory in a given year. It thus includes domestically performed R&D that is financed from abroad but excludes R&D funds paid abroad, notably to international agencies.

Headcount refers to the actual number of people directly involved in or supporting R&D (i.e. the total number of R&D personnel).

HERD refers to higher education expenditure on research and experimental development.

In-house or intramural R&D refers to R&D performed by the unit or entity itself (i.e. by the personnel of the unit or entity). This is R&D performed within the borders of Rwanda, even if funded by foreign sources.

Labour costs comprise annual wages and salaries and all associated costs or fringe benefits, such as bonus payments, holiday pay, contributions to pension funds and other social security payments, and payroll taxes. The labour costs of persons providing indirect services that are not included in the personnel data (such as security and maintenance personnel or the staff of central libraries, computer departments or head offices) are excluded from labour costs and included in other current expenditure.

National R&D efforts can be measured based on the main expenditure aggregate used for international comparison, which is the *R&D intensity.*

New materials refer to the technology and R&D activities of high-technology companies particularly in the aerospace, construction, electronic, biomedical, renewable energy, environmental remediation, food and packaging, manufacturing and motorcar industries. New materials include multi-functional materials, advanced materials, nano-materials, nano-composites and nanotechnology.

Other current expenditure comprises non-capital purchases of materials, supplies and equipment to support R&D performed by the reporting unit in a given year.

Other support staff includes skilled and unskilled craftspeople, secretarial and clerical staff participating in R&D projects or directly associated with such projects.

Outsourced R&D refers to R&D done by another entity on behalf of the reporting unit and paid for by the reporting unit.

Research and experimental development (R&D) comprises of creative and systematic work undertaken in order to increase the stock of knowledge - including knowledge of humankind, culture and society - and to devise new applications of available knowledge.

Researchers are professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems, and in the management of the projects concerned.

Research field (RF) refers to a branch of science, either natural or social and humanities sciences.

R&D facilities indicate the measure of facilities available for R&D. These include but are not limited to standardized equipment, library facilities, laboratory space, journal subscription, and time allocated to R&D activities.
R&D intensity refers to GERD as a percentage of GDP.

R&D personnel includes all persons (irrespective of nationality) employed directly on R&D activities, as well as those providing direct services, such as R&D managers, administrators, technicians and clerical staff. These include emeritus professors, honorary fellows and research fellows**.**

R&D-performing sectors comprise the government, higher education, business enterprise and private not-for-profit institutional sectors:

- **Government Sector:** This sector includes all bodies, departments and establishments of central government, state or local, districts that engage in a wide range of activities, such as: administration; defense and regulation of public order; health; education; cultural; recreational, and other social services; promotion of economic growth and welfare; and technological development.
- **Higher Education Sector:** This sector is composed of all universities, colleges of technology, and other institutions of post-secondary education, whatever their source of finance or legal status. It also includes all research institutes, experimental stations and clinics operating under the direct control of or administered by or associated with higher education institutions.
- **Private Non-profit Sector:** This sector covers R&D financed by Non-Public Institutions (NPIs) serving households. These provide individual or collective services to households either without charge or at prices that are not economically significant. The survey targets all private non-profit organizations including civil societies performing R&D.
- **Business enterprise Sector:** All firms, organizations and institutions whose primary activity is market production of goods or services for sale to the general public at an economically significant price. These include: Large, Medium, Small, and Micro (according to the number of employees and/or investment capital) business enterprises, including state - owned enterprises.

Technicians and equivalent staff are persons whose main tasks require technical knowledge and experience in one or more fields of engineering, physical and life sciences, or social sciences, humanities and the arts.

Total employment is the total employed labour force in the Rwandan economy. This statistic is obtained from NISR Labour Force Survey Annual Report 2019 (NISR, 2020) where employed persons were defined as those aged 16 years or above who worked for pay or profit.

Year-on-year changes are calculated as follows: (current year's figure - previous year's figure) / previous year's figure × 100%.

EXECUTIVE SUMMARY

This report presents results from the second Rwanda National Research and Experimental Development (R&D) Survey for the reference year 2018/2019 conducted by the National Council for Science and Technology (NCST). The current report takes into consideration results of the first R&D Survey for the reference year 2015/2016 for comparison and analysis.

In current values, the Gross Domestic Expenditure on R&D (GERD) has increased. GERD amounted to 70,601,673,966 Rwf in 2018/2019 from 44,457,113,816 Rwf in 2015/2016. Consequently, R&D intensity, which is the GERD as a percentage of GDP increased slightly, rising by only three basis points from 0.66% in 2015/2016 to 0.69% in 2018/2019.

R&D expenditure increased in all sectors in 2018/2019. The government sector leads on R&D expenditure with 63.58%, followed by the higher education sector at 22.97%, the business enterprises at 7.93%, and the private-non-profit organizations at 5.50%.
It is important to assess how R&D expenditure is also expressed to reflect the ratios spent on each type of research conducted. It was established that in general, majority of the resources were dedicated to basic research (40.22%), followed by applied research (35.13%) and experimental development (24.65%) of the total resources allocated to research in 2018/2019. This is in contrast to 2015/2016 where majority of the resources were dedicated to experimental development (55.64%), followed by applied research (25.51%) and basic research taking 17.84% of the total resources allocated to research.

The sources of R&D funding included funds from R&D performing institutions (own funds), funds from the government, funds from the business and PNP sectors or individual donations (firms) and foreign funds. The total funds for the period under consideration totalled 68,601,617,986 Rwf. The survey established that 58% of the total funds came from the government funds, 24.6% from foreign funds, 11.2% from own funds and 6.2% from firms. As a proportion of total funds during the reference year, in 2018/2019 foreign funds decreased to 24.67% from 26.253% in 2015/2016. Furthermore, the government funds accounting for 58% of the total funds in 2018/2019 was more than the total funds from all national sources in 2015/2016 which accounted for 54.44% of the total funds.

The survey established the total R&D personnel in headcounts and in FTEs by R&D occupation, qualification level, gender and R&D-performing sector. Regarding headcounts, Rwanda had 3,411 R&D personnel in 2018/2019, a lot more than 722 R&D personnel in 2015/2016. Of the 3,411 R&D personnel in total headcount, researchers accounted for 56.4% of the total R&D personnel, technicians accounted for 22.2% and support staff accounted for 21.4% of the total R&D personnel.
With a total of 1,924 researchers, Rwanda has a score of 152.33 researchers per 1 million inhabitants. In this regard, Rwanda still ranks much lower than R&D power houses such as South Africa and Egypt with a score of 1,084 and 1,408 respectively. The countries such as Morocco and Singapore, respectively have a score of 1,428 and 7,493 researchers per 1

million inhabitants. Of the 3,411 R&D personnel across all sectors, females accounted for 35.73%, a commendable progress from 25.07% in 2015/2016, which makes Rwanda rank fairly well regionally and internationally. However, more efforts still need to be put in place to boost the number of qualified female researches in all sectors, especially in the higher education sector. In fact, the survey findings indicated that of the 1,924 researchers across all sectors in 2018/2019, females accounted for 30.4%, also a fairly commendable progress from 22.64% in 2015/2016. In terms of researcher qualification level, the survey established that 25% of researchers hold a Doctoral degree qualification, and 47.09% are at Masters' level. This means that 72.09% of total researchers in R&D have qualifications of a Masters or above. Among technicians and support staff, the majority are at the level of Bachelors' degree or below. Furthermore, it was recorded that the total female research input in terms of full time equivalent is 280 for 585 females; whereas 462 full time equivalent is for 1,339 male researchers.

In terms of scientific publications, the total R&D output across all sectors for Rwanda in the reference year 2018/2019 was 3,081 distributed across areas all fields of research and R&D performing sectors. Of the 3,081 publications in total, there were 1,031 books/reports, 1,531 papers, and 519 doctoral/master's theses. The survey also established that there were 42 research awards of which 73.8% of them are recorded in the higher education. The higher education took the lead in registering the highest proportion of publications. For example, 77.4% of published papers were recorded in higher education sector followed by the government sector at 7.8%, while the business and PNP sectors contributed 2.9% and 2.3% respectively. Moreover, the highest proportion of published books/reports of 40% was observed in the higher education sector followed by the government sector at 29.8%, while the PNP and business sectors contributed 20.8% and 9.5% respectively.

In terms of intellectual property rights, among 550 which have been applied for, 464 have been granted. Of the 464 granted intellectual property rights, there were 96 utility models, 24 industrial designs, 15 integrated circuits, 40 trademarks, 114 patents, 95 copyrights, and 80 service marks. The highest proportion of service marks was registered in the business sector at 47.5% followed by the PNP sector at 26.3%, while the government and higher education sectors registered a contribution of 15.0% and 11.3% respectively.

In terms of collaboration efforts, the survey established that there were more national partnerships in research than foreign partnerships. National partnerships accounted for 54.7% of the total collaborations. The highest national collaboration was among the PNP sector followed by the government sector accounting for 39.36% and 21.83% of all national collaborations counted respectively. On the other hand, the largest foreign collaboration was recorded in the higher education sector followed by the PNP sector accounting for 45.54% and 19.17% of all foreign collaborations counted respectively.

Based on the findings of the R&D survey, key recommendations are formulated based on the four indicators, namely R&D expenditure, R&D funding, R&D personnel and R&D output.

Concerning R&D expenditure, there is a need to continue increasing the overall Gross Domestic Expenditure on R&D (GERD) in order to meet the target R&D intensity of 1% of GDP recommended by the African Union. Moreover, there is a need to increase academia-industry collaboration for the up-take and performance of collaborative R&D projects within the business sector.

For R&D funding, Public-Private sector collaboration needs to be strengthened in order to take advantage of the country's researcher base in a way that stimulates business R&D investment. There is a need to put in place policies that encourage companies to undertake R&D within the country. Moreover, most of Higher Learning Institutions don't have an R&D dedicated budget and simply rely on foreign funding and donations. In this regard, HLIs need to have an R&D strategy aligned with the country's vision and therefore efforts need to be put in place to stimulate government and business sectors funding to higher education sector R&D.

In terms of R&D personnel and output, more efforts are required to increase the number of researchers, particularly the number of qualified female researchers in all sectors, especially in the higher education sector to promote equal participation of women and men in performing R&D which leads to increased productivity and better scientific outputs. In this regard, a special funding scheme attracting women is recommended to build the capacity and increase the number of women involved in R&D activities. In general, the country's human capital and its research outputs need to be increased so that the national system of innovation can contribute optimally to Rwanda's socio-economic development targets.

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1. INTRODUCTION

1.1. BACKGROUND

In 2017, the government of Rwanda adopted the National Strategy for Transformation (NST1) which acknowledges the need to establish capacities and capabilities in areas of scientific research and technology innovation across its three pillars: Economic transformation, Social transformation, and Transformational governance. This strategy is expected to lay the bridge from sustained growth registered over the last two decades to the transformation that will accelerate the move towards achieving high standards of living for all Rwandans. Moreover, as established in her vision 2050, Rwanda aspires to achieve upper middle-income status by 2035 and become a high-income country by 2050.

Research and Experimental Development (R&D) is one of the key enablers and core pillars of the transformation of Rwanda into a knowledge-based, service-oriented economy needed to achieve the Vision 2050. In this regard, Rwanda is engaged in various strategic initiatives to strengthen her R&D Ecosystem, through for example the network of centers of excellence, R&D institutes and tech business centers. Furthermore, in June 2020, the parliament approved the national Science, Technology, and Innovation (STI) Policy that stipulates strategic objectives and policy actions that guide the interventions in science, technology, research and innovation towards becoming a knowledge-based economy.

This is in line with the Government of Rwanda's continued and consistent investment in research and innovation activities. Moreover, the government of Rwanda has established the National Research and Innovation Fund (NRIF) to facilitate researchers and innovators who are expected to play a critical role in finding solutions to address social, economic and environmental challenges, as well as increasing research productivity, and stimulate competitiveness.

In order to strategically leverage the existing efforts and increase the efficiency and socio-economic impact of previous, current and future R&D-related investments, there is a need for periodic collection of R&D statistics to support informed decision-making in both the public and private sectors. It is within this background that, The National Council for Science and Technology (NCST), as a national institution in charge of public advisory, with a mandate of providing informed and strategic policy recommendations and advice to the Government of Rwanda on issues pertaining to the development of Science, Technology, Research and Innovation (STRI); periodically collects and analyzes the R&D data. The findings facilitate the measurement and provision of policy advice to the Government on STRI policy implementation, policy targets and priorities.

In order to gauge the state, performance and impact of the various R&D investments, NCST conducted the Rwanda National Research and Experimental Development (R&D) Survey for the reference year 2018/2019, considering the previous survey of 2015/2016 as the baseline.

The survey covers the four R&D-performing sectors in Rwanda, namely, the government, higher education, business enterprise and private non-profit sectors. This approach is followed in order to maintain consistency with the categorization of institutional sectors recommended by the Organization for Economic Cooperation and Development (OECD) in the Frascati Manual (OECD, 2015), which proposes standard practice for surveys on Research and Experimental Development.

1.2. OBJECTIVES OF THE SURVEY

The overall goal of the Rwanda National Research and Experimental Development (R&D) Survey is to assess R&D status using international standard R&D indicators with the aim to monitor the performance, outcome and impact of the country's investment in Science, Technology, Research and Innovation (STRI) during the reference year 2018/2019. The survey findings will serve as a basis for identifying strategic and customized interventions to support and promote research performance and impact.

The National R&D Survey has the following specific objectives:

(i) To determine the R&D expenditure measures in the government, higher education, business and private non-profit sectors, and the overall Gross Expenditure on R&D;
(ii) To determine the country's R&D intensity; and measure the level at which basic, applied and experimental research are conducted in the country;
(iii) To determine the R&D funding by source and sector of performance;
(iv) To determine the R&D personnel by level of formal qualification and occupation, gender, headcount, and Full Time Equivalent who are directly involved and participate in implementation of R&D activities;
(v) To assess research productivity including R&D outputs in terms of publications and intellectual property rights;
(vi) To provide relevant international comparisons in terms of R&D survey statistics.

This report presents results from the second Rwanda National Research and Experimental Development (R&D) Survey for the reference year 2018/2019 conducted by the National Council for Science and Technology (NCST). The current report takes into consideration results of the first R&D Survey for the reference year 2015/2016 for comparison and analysis. The analysis is made according to the following indicator categories (OECD. 2020b):

(i) Gross domestic expenditure on research and experimental development (GERD), and R&D expenditure by R&D-performing sectors; R&D expenditure by field of research;
(ii) National and foreign sources of funding for R&D sectors;
(iii) R&D personnel;
(iv) R&D output.

2. SURVEY METHODOLOGY

2.1. SURVEY DESIGN AND SAMPLING

The Rwanda National Research and experimental Development (R&D) Survey forms part of the tools for monitoring and evaluating the performance of the National System of Innovation (NSI). It covers four main sectors described in the Frascati Manual: government, higher education, business enterprise, and private non-profit sectors.

The scope of the survey includes all units performing and likely to perform R&D, either continuously or occasionally. Data obtained from the survey are presented and analyzed taking into account time series recorded from previous surveys.

The survey collects data using four questionnaires in accordance with the guidelines recommended by the OECD in the Frascati Manual (OECD, 2015). This helps to maintain coherence and international comparability.

In the interests of coherence of its data with other national survey data, the Rwanda National R&D Survey takes care to use standards and methods applied and recommended by The National Institute of Statistics of Rwanda (NISR). Indicators that use external data are sourced from NISR surveys: gross domestic product value is the value for 2019 reported by the World bank (see also NISR, 2021), and employment level is the value for the 2019 Labour Force Survey Annual Report (NISR, 2020). The figure for the total population in Rwanda in 2019 is taken from worldometers (see worldometers.info).

2.1.1. Government sector

In accordance with the Frascati Manual (OECD, 2015), the scope government sector comprised of all institutions which receive budget allocation from the central treasury. The survey administered a census approach covering all government institutions including ministries, government agencies, and government research institutes. The government sector surveyed 92 institutions.

2.1.2. Higher education sector

The survey also administered a census approach in the higher education sector, covering all public and private tertiary institutions operating in Rwanda. Accordingly, 45 institutions were sampled. These include the University of Rwanda (UR), Colleges and Centers of excellence of UR, Rwanda Polytechnic and its Integrated Polytechnic Regional Centers (IPRCs), and Private Universities.

2.1.3. Business sector

The survey administered a random sampling approach in the business sector using the list of business entities registered in Rwanda as sampling frame. Accordingly, the business sector surveyed 1,011 business sector units.

2.1.4. Private non-profit sector

The survey also administered a random sampling approach in the private non-profit sector using the list of both local and international NGOs registered in Rwanda as sampling frame. Accordingly, the private non-profit sector surveyed a total of 417 units.

2.2. RESPONSE RATE

The total number of entities sampled for the R&D Survey 2018/2019 was 1,565 entities including 92 government institutions, 45 higher learning institutions, 1,011 business enterprise units, and 417 private non-profit organizations. Of the 1,565 targeted respondents, 1,410 responded. This reflects an overall response rate of 90.16% as shown in Table 1 below.

Table 1: Percentage response rates per sector and overall survey response rate

Sector	Government sector	Higher education sector	Business sector	PNP sector	Overall
Sample size	92	45	1011	417	**1,565**
Number responded	88	42	863	417	**1,410**
Response rate (%)	95.65	93.33	85.36	100	**90.1**
Non-response rate (%)	4.35	6.66	14.64	0.00	**9.9**

2.3. SURVEY INDICATORS

This report provides data on multiple key R&D indicators with the purpose of advising the Government and informing public policy development on R&D-related matters. In line with international best practices, R&D statistics are gathered periodically to gauge the state and track progress as well as enable international comparison. In this regard, the current report also provides analysis of current data in comparison with data from the previous survey of 2015/2016 to show R&D progress made.

To showcase the state and performance of R&D across Rwanda, the Survey adopted a set of indicators encompassing various R&D-related activities, inputs, outputs, and outcomes. The collected data is organized into indicators that are internationally comparable, as well as indicators that are most relevant to the Rwandan context. These indicators speak not only to activities and outcomes, but perceptions on the state of Science, Technology, Research, and Innovation.

The current report presents data on the following key indicators balanced under 4 categories: R&D Expenditure, R&D Funding, R&D Personnel, and R&D Output.

Table 2: Summary of the key indicators

Category	Indicator	Note on information provided
1. R&D Expenditure		
	GERD	Gross Domestic Expenditure on R&D
	GERD as a Percentage of GDP	R&D intensity indicated by GERD as a percentage of GDP
	GERD by Sector of Performance	Statistics on GOVERD, BERD, HERD, PNPERD
	GERD by type of research	R&D expenditure by basic, applied, or experimental research across sectors
	GERD by Line of Expenditure category per Sector	GERD by capital and current R&D expenditure per sector
	GERD by expenditure on multidisciplinary areas	GERD by expenditure on multidisciplinary areas of R&D across the four sectors
	GERD by expenditure on research fields	GERD by expenditure on natural science, engineering and technology, medical, social, agriculture sciences etc.
	Outsourced R&D	Expenditure on outsourced R&D activities across the four sectors
2. R&D Funding		
	Funding for R&D by source of funding	Funding for R&D by own funds, government, firms or foreign funding across the four sectors
	Government-funded R&D	Total government-funded R&D across the four sectors
	Business-funded R&D	Total business-funded R&D across the four sectors
	Foreign-funded R&D	Total R&D funding from abroad across the four sectors
3. R&D Personnel		
	R&D personnel in headcounts by occupation	Total researchers, technicians and other support staff in headcounts
	R&D personnel in full-time equivalents by occupation	Total researchers, technicians and other support staff in full-time equivalents
	R&D personnel in headcounts by occupation and gender	Total researchers, technicians and other support staff in headcounts by gender
	R&D personnel in full-time equivalents by occupation and gender	Total researchers, technicians and other support staff in full-time equivalents by gender

	R&D personnel in headcounts by sector	Total researchers, technicians and other support staff in headcounts across the four sectors
	R&D personnel in full-time equivalents by sector	Total researchers, technicians and other support staff in full-time equivalents across the four sectors
	Researcher headcounts by sector	Total researchers in headcounts across the four sectors
	Researcher headcounts by gender	Total researchers in headcounts by gender
	Researchers by Field of Engagement	Total researchers by field of research: Natural sciences, engineering and technology, Medical and health sciences, etc.
	R&D personnel in headcounts by qualification level	Total R&D personnel in headcounts by qualification level: Doctoral, Masters, Bachelors, etc.
	R&D personnel in full-time equivalents by qualification level	Total R&D personnel in full-time equivalents by qualification level: Doctoral, Masters, Bachelors, etc.
4. R&D Output		
	R&D output in publications	Total number of publications (books, papers, etc.) across the four Sector
	R&D output in intellectual property rights	Total number of intellectual property rights (utility models, trademarks, patents, etc.) applied for and granted across the four sectors
	Collaborative R&D	Research collaboration efforts both national and international

3. SURVEY FINDINGS

3.1. R&D EXPENDITURE

Research and Experimental Development (R&D) is recognized as a powerful driver of innovation and its level of investment proves to be correlated to economic growth, employment and competitiveness. R&D outlays are expenditures on innovation activities which, accumulated, are believed to create the stock of knowledge for the country. As an African Union (AU) member, Rwanda aims to promote R&D and foster innovation strategies for wealth creation and economic development by allocating at least 1% of Gross Domestic Product (GDP) to R&D investments as recommended by the Khartoum Decision[1] (AU, 2007) and by the Lagos plan of action of 1980[2] (OAU, 1980).

3.1.1. Gross domestic expenditure on R&D

Gross domestic expenditure on research and experimental development (GERD) amounted to Rwf 70,601,673,966 in 2018/2019 (Table 3). In nominal terms, this represents an increase of Rwf 26,144,560,150 from the Rwf 44,457,113,816 recorded in 2015/2016.

Table 3: GERD in current Rwf value and GERD as a percentage of GDP, 2015/2016 to 2018/2019

Indicator	Value	
	2015/2016	2018/2019
Gross domestic expenditure on R&D (GERD) (Rwf)	44,457,113,816	70,601,673,966
GERD as a percentage of GDP (%)	0.66	0.69

Definition	GERD expressed as a percentage of GDP indicates the R&D intensity in an economy, and is a measure of the innovation capacity as well as a measure of investments on innovation strategies for wealth creation and economic development.
Data sources	GDP: gross domestic product value is the value for 2019 reported by the World bank (see also NISR, 2021). R&D expenditure: Rwanda National Survey of Research and Experimental Development, 2015/2016 to 2018/2019.

3.1.2. GERD as a percentage of GDP

GERD as a percentage of GDP, a measure of R&D intensity in Rwanda, was 0.69% in 2018/2019 (Table 3). This indicator increased by three basis points from 0.66% in 2015/2016. Furthermore, this informs on the substantial progress made by Rwanda towards meeting the 1% R&D intensity target by African nations.

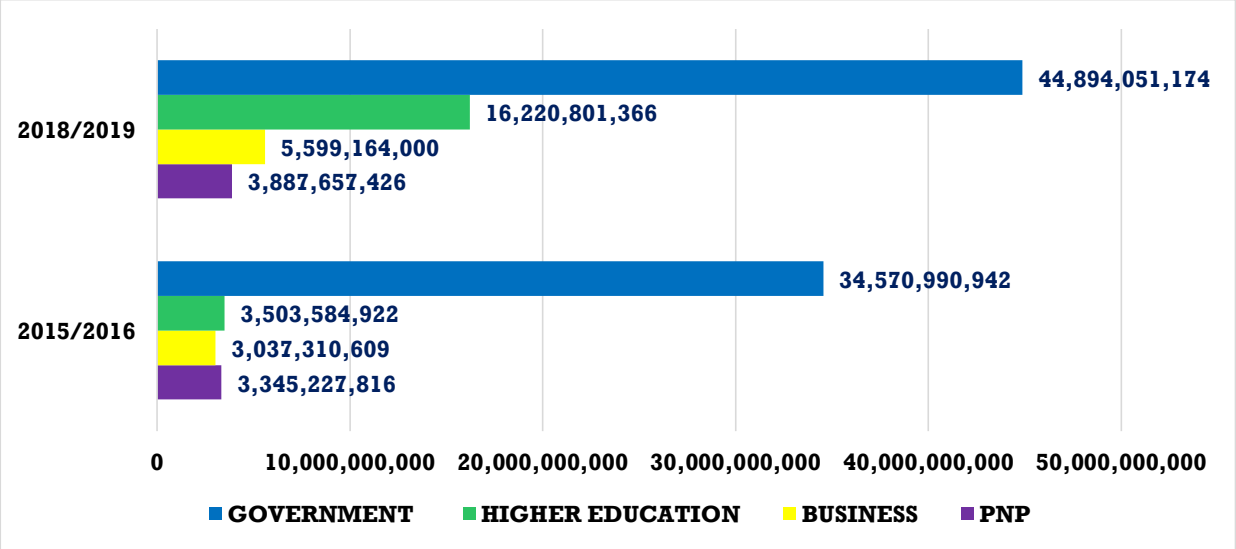
[1] Decision and declaration of the Assembly of the African Union Eight Ordinary Session 29-30 January 2007, Ethiopia

[2] The Assembly of Heads of State and Government of the Organisation of African Unity, meeting in its Second Extraordinary Summit, in Lagos, Nigeria, from 28 to 29 April 1980

3.1.3. GERD by institutional sector

The government sector remained the largest performer of R&D in Rwanda in 2018/2019 (Figure 1). Government expenditure on R&D (GOVERD) constituted 63.6% of GERD. It amounted to Rwf 44,894,051,174, representing a year-on-year[3] increase of 30% from Rwf 34,570,990,942 in 2015/2016. The second largest performer of R&D was the higher education sector. The higher education sector R&D expenditure (HERD) increased by 363% from Rwf 3,503,584,922 in 2015/2016, to Rwf 16,220,801,366 in 2018/2019 and constituted 23% of GERD. Business enterprise expenditure on R&D (BERD) in 2018/2019 at current expenditure amounted to Rwf 5,599,164,000, which is equivalent to 7.93% of GERD. Even though the BERD is still very low, the recorded year-on-year increase from 2015/2016 to 2018/2019 in BERD of 84.35% is large compared to the overall growth in GERD year-on-year of 58.81%. Private Non-Profit (PNP) organizations recorded a 16% increase in R&D expenditure from Rwf 3,345,227,816 in 2015/2016 to Rwf 3,887,657,426 in 2018/2019. While this increase is significant for the PNP sector, it had little impact on the overall growth rate of GERD in 2018/2019.

Figure 1: R&D expenditure by sector (Rwf), 2015/2016 to 2018/2019



Definition	The Frascati Manual (OECD, 2015) defines the R&D-performing sectors as the government, higher education, business and Private Non-Profit (PNP) sectors. The current survey followed this approach in order to maintain consistency with the recommended categorization of institutional sectors.
Data sources	Rwanda National Survey of Research and Experimental Development, 2015/2016 to 2018/2019.

[3] Year-on-year changes are calculated as follows: (current year's figure - previous year's figure) / previous year's figure × 100%

3.2. FUNDING FOR R&D

3.2.1. Main flows of R&D funding

The total funds for the period under consideration totalled 68,601,617,986 Rwf. The survey established that the government funded the largest proportion of R&D in Rwanda in 2018/2019 (Table 4, Figure 2). However, government funding decreased by 10.54% from Rwf 44,455,194,309[4] (counting all funds from all other national sources including funds from both the government and firms) in 2015/2016 to Rwf 39,771,241,936 in 2018/2019, representing 58% of the total R&D funding. Furthermore, looking at it as the proportion of total funds, the government funds accounting for 58% of the total funds in 2018/2019 was more than the total funds from all other national sources in 2015/2016 which accounted for 54.44% of the total funds. The largest share of total government funding went to the government sector, which received 85.11% (Rwf 33,851,017,662). The higher education sector received 10.86% (Rwf 4,319,474,274) of total government R&D funding. The business and private non-profit sectors were the smallest recipients of direct R&D funding from government, receiving 2.76% (Rwf 1,098,600,000) and 1.27% (Rwf 502,150,000) respectively.

The second largest source of funding for R&D in 2018/2019 was from abroad. Foreign funding amounted to Rwf 16,915,453,342 in 2018/2019 from Rwf 15,915,315,685 in 2015/2016. However, as a proportion of total funds, foreign funding decreased by 1.583%, from 26.253% in 2015/2016 to 24.67% in 2018/2019. Furthermore, the largest share of total foreign funding went to the higher education sector, which received 94.57% (Rwf 15,997,443,342).

R&D performing institutions own funds was the third largest source of R&D funding, contributing 11.2% (Rwf 7,672,839,558) towards total national R&D funding. Government sector has the largest share of own funds of 51.76% (Rwf 3,971,185,834) followed by the business sector at 22.41% (1,719,742,850), the higher education sector at 20.93% (1,605,910,874), and the Private Non-Profit sector at 4.90% (376,000,000).

The smallest proportion of total R&D funds came from firms amounting at only 6.2% (Rwf 4,242,083,149). The largest share of firms funding went to the Private-Non-Profit sector at 43.1% (1,828,250,001), followed by the government sector at 42.29% (1,794,133,148), the higher education sector at 9.43% (400,000,000). The business sector was the smallest recipient of direct R&D funding from firms, receiving 5.18% (Rwf 219,700,000).

[4] For the 2015/2016 R&D Survey, total funds from both the government and firms were reported together as funds from national sources

Table 4: Distribution of R&D funding (Rwf) through various sources 2018/2019

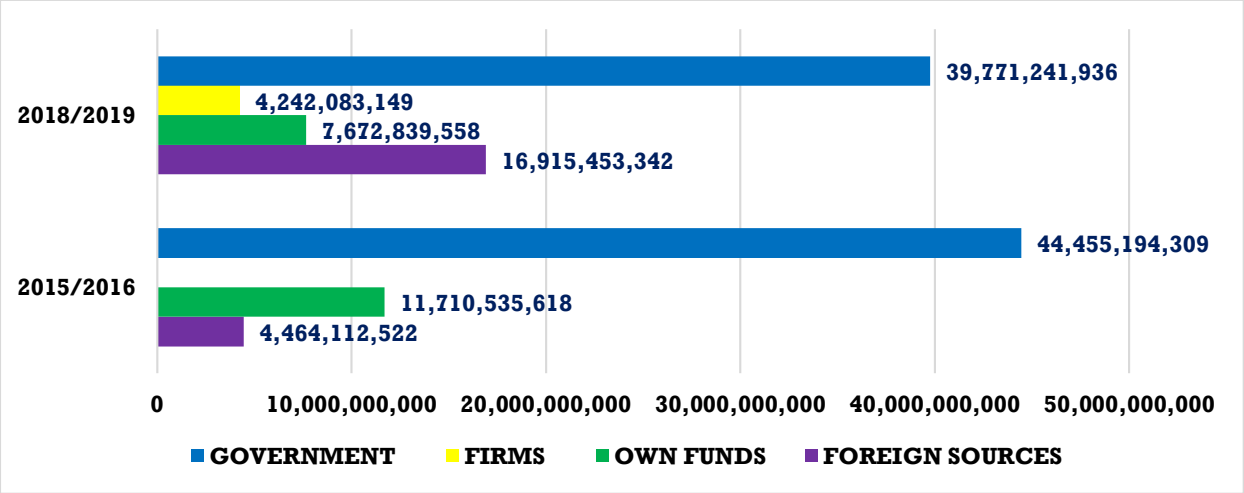
Source of funding	Government sector	Higher education sector	Business sector	Private Non-Profit sector	Total
Own funds	3,971,185,834	1,605,910,874	1,719,742,850	376,000,000	**7,672,839,558**
Government	33,851,017,662	4,319,474,274	1,098,600,000	502,150,000	**39,771,241,936**
Firms	1,794,133,148	400,000,000	219,700,000	1,828,250,001	**4,242,083,149**
Foreign	390,000,000	15,997,443,342	354,200,000	173,810,000	**16,915,453,342**
TOTAL	**40,006,336,644**	**22,322,828,491**	**3,392,242,850**	**2,880,210,001**	**68,601,617,986**

Data note	The sources of R&D funding included funds from R&D performing institutions' own budget (own funds), funds from the government, funds from the business and PNP sectors, individual as well as other private national funding agencies donations (firms) and foreign funds
Data sources	Rwanda National Survey of Research and Experimental Development, 2018/2019.

3.2.2. GERD by sources of funds

Government has funded the largest proportion of GERD in Rwanda (Figure 2) in 2015/2016, which continued in 2018/2019. The proportion of GERD funded by the government was 56.33%, followed by foreign funding at 23.96%, own funding at 10.87% and firms at 6.01%.

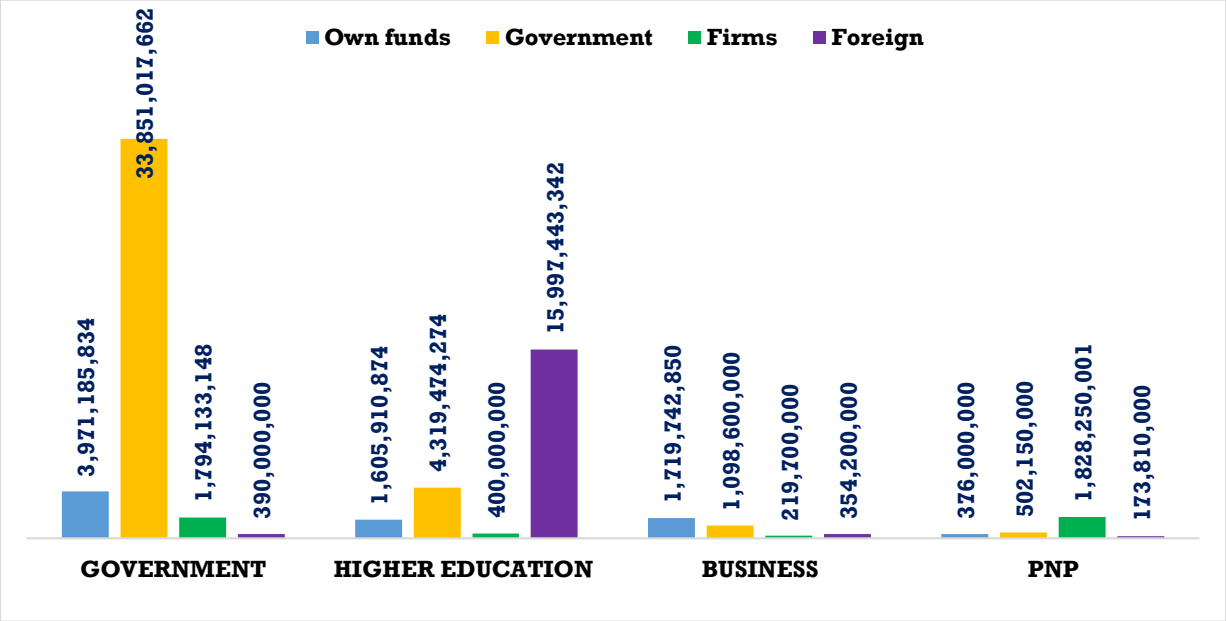
Figure 2: GERD by source of funds (Rwf), 2015/2016 to 2018/2019



Data note	For the 2015/2016 R&D Survey, total funds from both the government and firms were reported together as funds from national sources. For simplicity, we present it here as government funding.
Data sources	Rwanda National Survey of Research and Experimental Development, 2015/2016 to 2018/2019.

Furthermore, the government mainly funds its own R&D activities using its own sources of funding. The business sector has made a commendable progress in funding its own R&D activities, but also still relies on the government funding for a large proportion of its R&D expenditure (Figure 3).

Figure 3: Sector comparison on source of funding, 2018/2019



Data sources	Own funds is the funding from the R&D-performing unit own budget
Data sources	Rwanda National Survey of Research and Experimental Development, 2018/2019.

3.2.3. Business-funded R&D

It is important to assess the business sector R&D investment, and how well it funds its own R&D activities and those of other sectors. In 2018/2019, the business sector's direct funding largely went to the Private Non-Profit and government sectors, both taking up almost exclusively 85.39% of total funding from firms. The third largest recipient of firms funding was the higher education sector at 9.43%. However, the business sector was the least funded, receiving only 5.18% of total funding from firms (Table 5).

Table 5: Business-funded R&D by sector, 2018/2019

Ref. Year	Total	Government sector	Higher Education	Business sector	Private Non-Profit sector
Business-funded R&D* (Rwf)					
2018/2019	4,242,083,149	1,794,133,148	400,000,000	219,700,000	1,828,250,001
Proportional business-funded R&D* (%)					
2018/2019	100	42.29	9.43	5.18	43.1

Data sources	Rwanda National Survey of Research and Experimental Development, 2018/2019.

3.2.4. Government-funded R&D

The government sector has proven to be the largest funder of R&D nationally (Table 6). In turn, the government institutions are by far the largest recipients of government funding, receiving 85.11%, followed by the higher education sector, receiving 10.86%. The trend is the same as for 2015/2016. However, nominally, in 2018/2019 government funding to higher education sector decreased to Rwf 4,319,474,274 (10.86%) from Rwf 10,670,377,138 (24.00%) in 2015/2016. It should be noted that government R&D funding to the higher education sector is not direct funding, instead it is through donations and grants from government institutions.

Table 6: Government-funded R&D by sector (2015/2016 and 2018/2019)

Ref. Year	Total	Government sector	Higher education sector	Business sector	Private Non-Profit sector
Government-funded R&D (Rwf)					
2015/2016	44,455,194,309	30,215,037,294	10,670,377,138	2,323,517,538	1,246,262,339
2018/2019	39,771,241,936	33,851,017,662	4,319,474,274	1,098,600,000	502,150,000
Proportional government-funded R&D (%)					
2015/2016	100	67.97	24	5.23	2.8
2018/2019	100	85.11	10.86	2.76	1.26

Data sources	Rwanda National Survey of Research and Experimental Development, 2015/2016 and 2018/2019.

3.2.5. Foreign funding of R&D

Foreign funding for R&D increased from Rwf 4,464,112,522 in 2015/2016 to Rwf 16,915,453,342 in 2018/2019. The current survey established that in 2018/2019 the largest share of 94.57% of foreign funds for R&D went to the higher education sector, increasing from 5.77% in 2015/2016. Moreover, foreign funds for R&D to the government sector decreased to 2.31% in 2018/2019 from 70.76% in 2015/2016.

Table 7: Foreign-funded R&D by sector (2015/2016 and 2018/2019)

Ref. Year	Total	Government sector	Higher education sector	Business sector	Private Non-Profit sector
Foreign-funded R&D (Rwf)					
2015/2016	4,464,112,522	3,158,966,208	257,396,314	839,710,000	
2018/2019	16,915,453,342	390,000,000	15,997,443,342	354,200,000	173,810,000
Proportional foreign-funded R&D (%)					
2015/2016		70.76	5.77	18.81	4.66
2018/2019		2.31	94.57	2.09	1.03

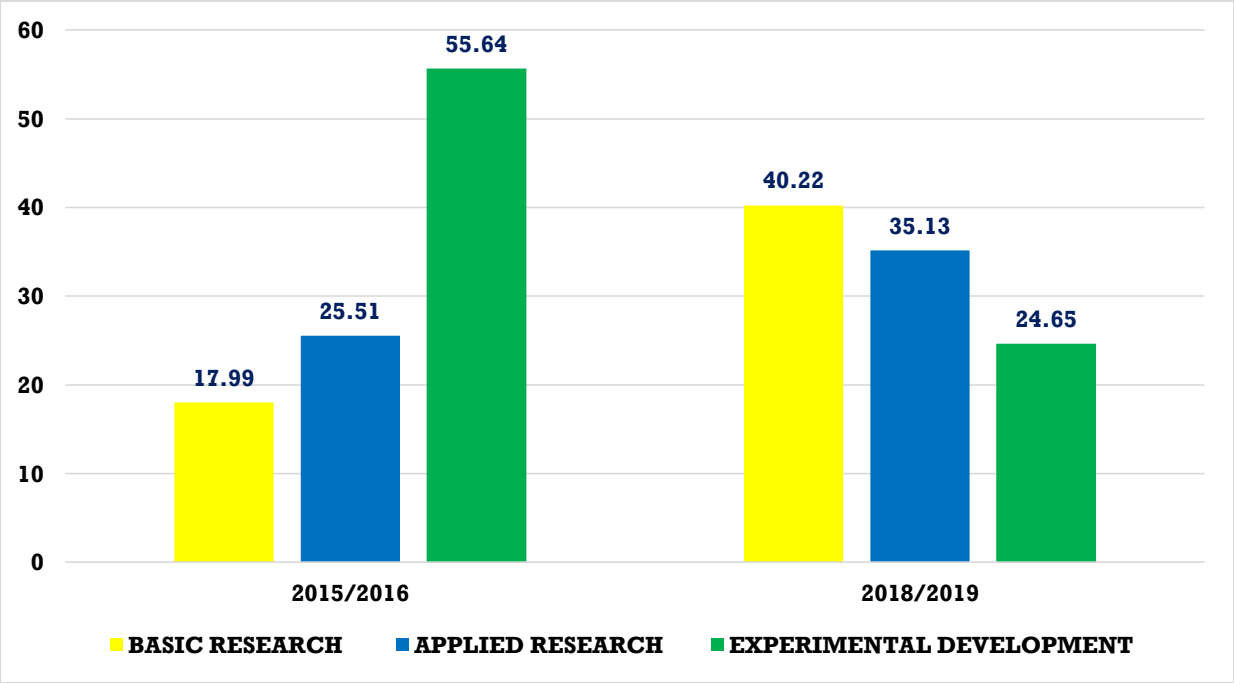
Data sources	Rwanda National Survey of Research and Experimental Development, 2015/2016 and 2018/2019.

3.3. FUNCTIONAL DISTRIBUTION OF R&D EXPENDITURE

3.3.1. GERD by type of research

It is important to analyze R&D expenditure not only from the perspective of the sectors in which expenditure occurs, but also to look at expenditure in types of research conducted. There was a notable increase in both basic and applied research and a decline in experimental development in the 2018/2019 reference year (Figure 4). The largest proportion of R&D expenditure was allocated to basic research (40.22%), followed by applied research (35.13%). As a result, the proportional share of expenditure allocated to the experimental development category reflects a decrease, from 55.64% in 2015/2016 to 24.65% in 2018/2019.

Figure 4: GERD by type of research (percentage), 2015/2016 to 2018/2019



Data note	The OECD's Frascati Manual defines three types of research: Basic research, Applied research and Experimental development (for more details, refer to Definition of Terms).
Data sources	Rwanda National Survey of Research and Experimental Development, 2015/2016 to 2018/2019.

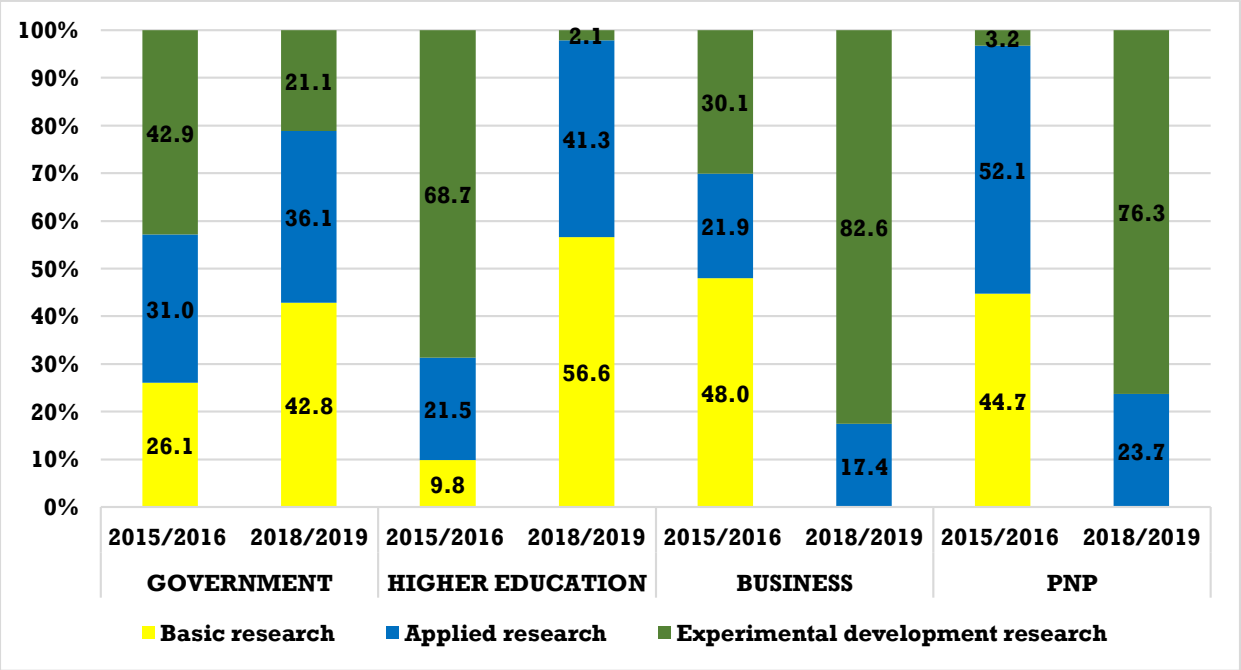
3.3.2. GERD by type of research and institutional sector of performance

In general, during the current reference year, both the government and higher education sectors increased the proportion of expenditure devoted to basic and applied research. As such the proportion of expenditure devoted experimental development decreased, the lowest proportion being 2.1% for experimental research conducted by the higher education sector.

In contrast, the business and PNP sectors devoted their expenditure almost exclusively to experimental development, increasing from 30.1% and 3.2% in 2015/2016 to 82.6% and 76.3% in 2018/2019 for the business sector and PNP sector respectively (Figure 5). The remaining proportion of 17.4% (Business sector) and 23.7% (PNP sector) was devoted to applied research in 2018/219. Therefore, the business and PNP sectors recorded no investment in basic research for 2018/2019.

The higher education sector reported the largest share of sector expenditure on both basic research (56.6%) and applied research (41.3%). The business sector reported the largest share of sector expenditure on experimental development (82.6%).

Figure 5: Percentage share of GERD by type of research, 2015/2016 to 2018/2019

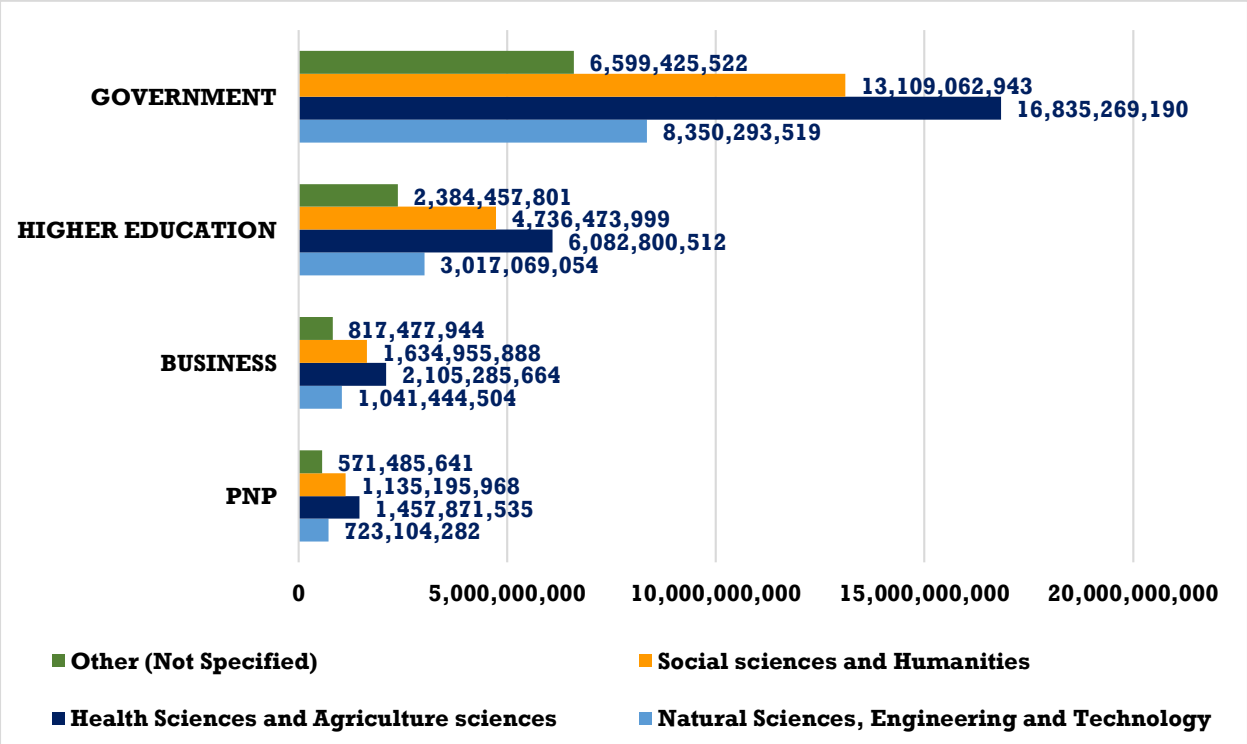


Data sources	Rwanda National Survey of Research and Experimental Development, 2015/2016 and 2018/2019.

3.3.3. GERD by division of research field and institutional sector of performance

The Rwanda National R&D Survey collects data for 6 fields of science and other (not specified) as classified by the Frascati manual. Figure 6 presents data aggregated into three major categories, and other (not specified) namely Division 1, which includes natural sciences, technology and engineering, Division 2, which represents medical, health, agriculture and veterinary sciences, and Division 3, which represents social sciences and humanities and art. Finally Division 4 represents the category of other (not specified). The survey established that the largest share of GERD representing 42.86% has been reported in medical, health, agriculture and veterinary sciences research fields. The second largest share of 33.37% of GERD has been reported in social sciences and humanities and art research fields. The research field of natural sciences, engineering and technology comes at the third place with a share of GERD equal to 21.26%, while other (not specified) category comes last with a share of 2.51%. This trend of proportional GERD share among the major categories of fields of science was observed across all four institutional sectors (Figure 6).

Figure 6: R&D expenditure by research field and sector, 2018/2019



Data note	The 2015 Frascati Manual classifies the Fields of Research (FORD) as follows: 1. natural sciences, 2. engineering and technology, 3. medical and health sciences, 4. agricultural and veterinary sciences, 5. social sciences, 6. humanities and art sciences and 7. other (not specified). Data in Rwanda is collected according to these FORD and, for convenience is aggregated into 3 categories and other.
Data sources	Rwanda National Survey of Research and Experimental Development, 2018/2019.

3.3.4. R&D expenditure by accounting category

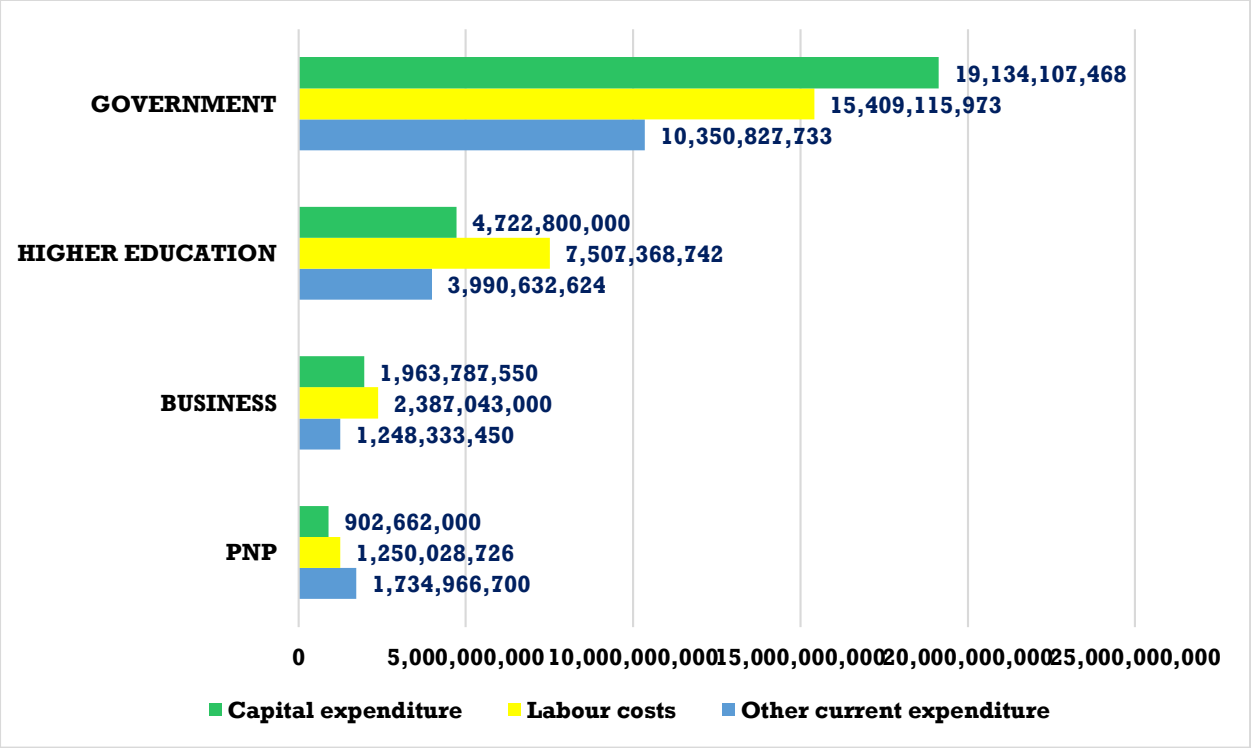
The Frascati Manual 2015 differentiates between two types of R&D expenditure: capital expenditure and current expenditure. The latter distinguishes between two types of costs, which are labour costs and other current costs. Capital expenditure comprises all annual gross expenditure on fixed assets used for R&D performance, and it includes acquisition of software and licensing fees, databases lasting for more than one year, major repairs and modifications on land and buildings. Labour costs of R&D personnel consist of annual wages, salaries and all associated costs or fringe benefits.

Capital expenditure has increased from Rwf 9,161,793,099 in 2015/2016 to Rwf 26,723,357,018 in 2018/2019. Moreover, Labour costs have increased from Rwf 8,856,266,075 in 2015/2016 to Rwf 26,553,556,441 in 2018/2019. The increase in labour costs is most likely a result of increases in the number of R&D personnel in both headcounts and FTEs across all the four sectors.

Other current expenditure comprises non-capital purchases of materials, supplies and equipment including office, computer and related equipment to support R&D performed by the reporting unit in a given year. The survey has established that other current expenditure has decreased from 26,439,054,642 in 2015/2016 to 17,324,760,507 in 2018/2019.

The survey established that in 2018/2019, the proportion allocated to capital expenditure was the highest for the government sector at Rwf 19,134,107,468. Furthermore the proportion allocated to labour costs was the highest for the government sector and the higher education sector at Rwf 15,409,115,973 and Rwf 7,507,368,742 respectively. Contrary to the PNP sector where labour costs were lower than other current expenditure, in the business sector labour costs were higher than other current expenditure (Figure 7).

Figure 7: R&D expenditure by accounting category, 2018/2019

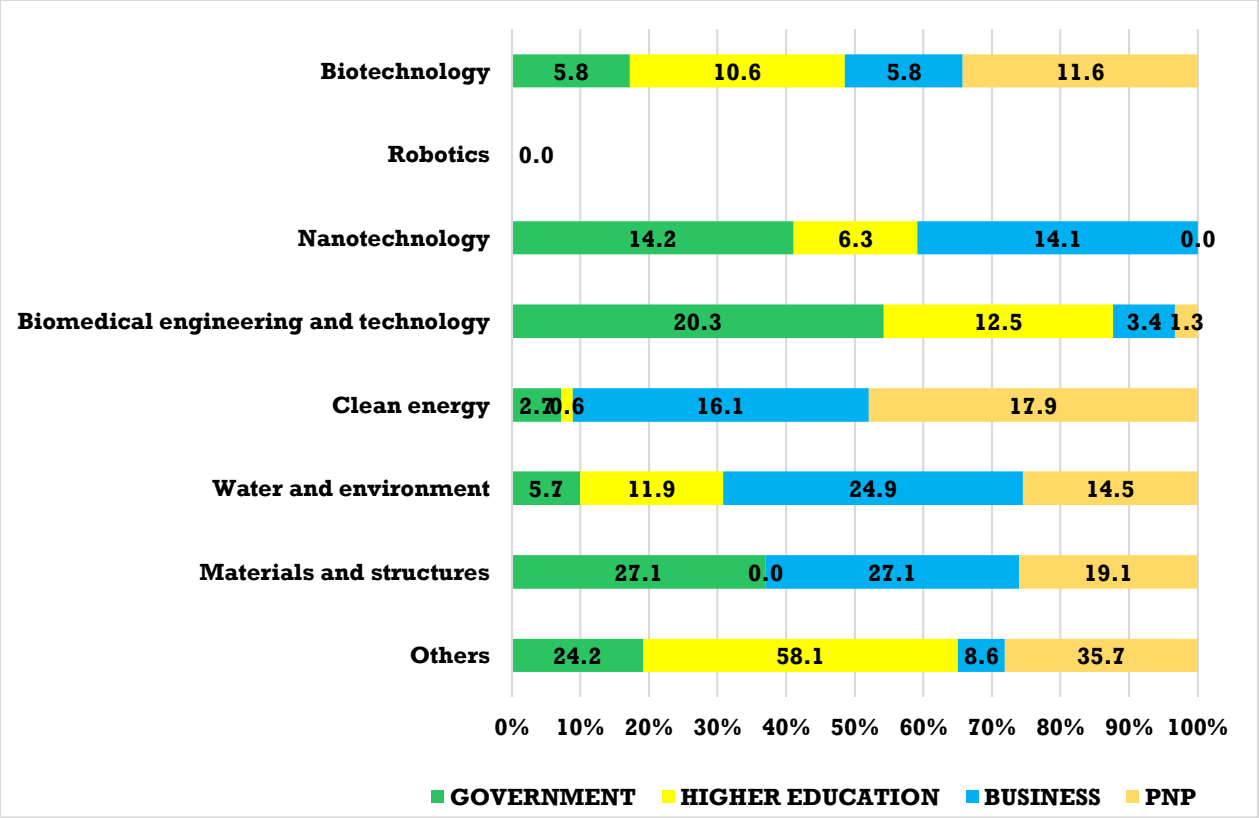


Data note	The 2015 Frascati Manual differentiates between two types of R&D expenditure: capital expenditure and current expenditure (labour costs and other current expenditure)
Data sources	Rwanda National Survey of Research and Experimental Development, 2018/2019.

3.3.5. R&D expenditure in multidisciplinary areas

The survey has established that during 2018/2019, no investment was made in the area of robotics. All sectors invested in biotechnology with higher education and PNP sectors leading at 11%, and government and business sector investing around 6% of their R&D expenditure. The PNP and business sectors lead in the areas of clean energy, water and environment while both PNP and business together with government lead in the area of material and structure. Furthermore, higher education and government lead the area of biomedical engineering and technology. The higher education sector takes the lead in the others category investing 58.1%, followed by PNP sector (35.7%) and government sector (24.3%). This category most likely includes the basic and applied research at a large extend for the higher education sector, and includes the social and experimental research for the PNP sector (Figure 8).

Figure 8: R&D expenditure in multidisciplinary areas (percentage), 2018/2019



Data note	The 2015 Frascati Manual defines the multidisciplinary areas: Biotechnology, Robotics, Nanotechnology, Biomedical engineering and technology, Clean energy, Water and environment, Materials and structures, Others.
Data sources	Rwanda National Survey of Research and Experimental Development, 2018/2019.

3.4. OUTSOURCED R&D

The survey set out to establish any outsourced or extramural expenditure on R&D; being the amounts a reporting unit paid or committed to pay to another organization for the performance of R&D during the specific reference year. This includes acquisition of R&D performed by and/or grants given to other organizations for performing R&D.

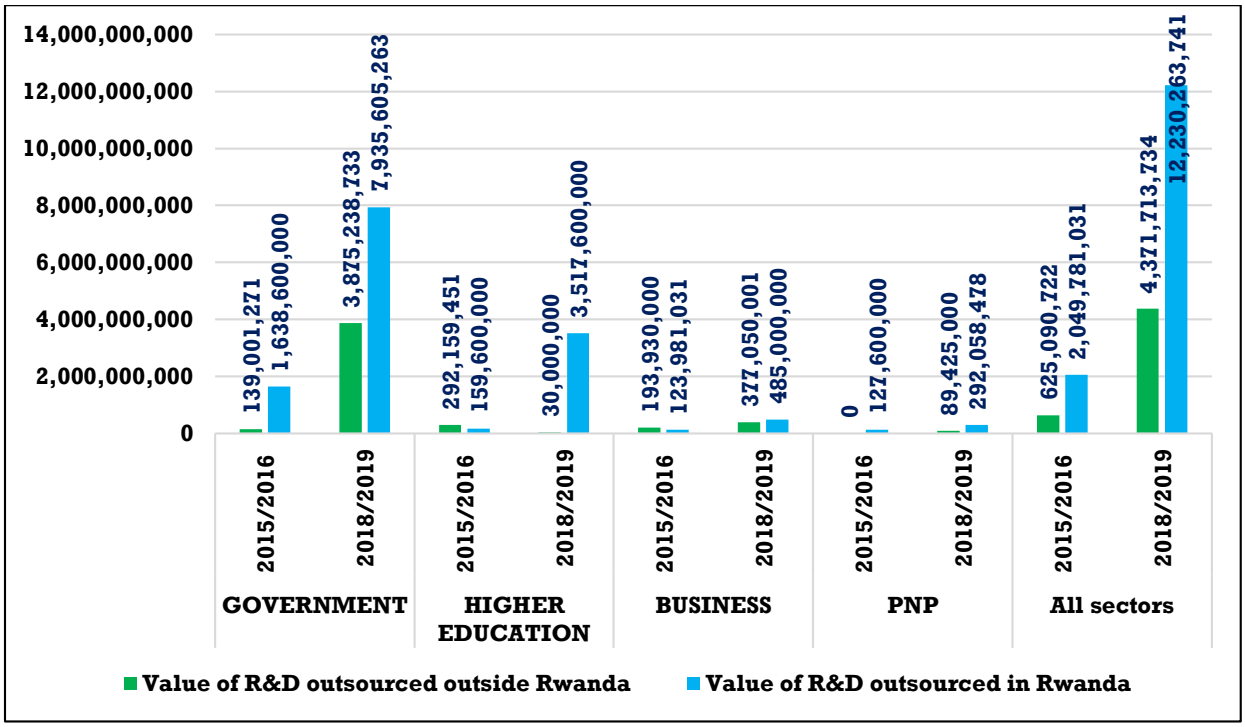
The current survey established that overall, Rwf 12,230,263,741 was spent on outsources R&D across all sectors in 2018/2019. This was a large increase from Rwf 4,996,804,456 spent on outsourced R&D across all sectors in 2015/2016 (Figure 9).

The government sector took the lead at contracting out R&D and acquiring R&D performed by others to a tune of Rwf 9,574,205,263 (67%), followed by the higher education sector at Rwf 3,677,200,000 (25.8%). This was most likely due to the acquisition of R&D potential in terms of

physical and soft infrastructure in both the government and higher education sectors. In addition, for the government sector this amount includes research grants provided to other institutions. The business sector was the third with a contribution of Rwf 608,981,031 (4.3%). Finally the PNP sector came in at Rwf 419,658,478 (2.9%).

The survey further established that 85.6% of the outsourced R&D was outsourced within Rwanda in 2018/2019, a decrease from 96.54% in 2015/2016. As such 14.4% of the outsourced R&D was outsourced outside of Rwanda in 2018/2019, an increase from 3.46% in 2015/2016.

Figure 9: Outsourced R&D expenditure, 2015/2016 to 2018/2019



Data note	Outsourced R&D refers to R&D done by another entity on behalf of the reporting unit and paid for by the reporting unit.
Data sources	Rwanda National Survey of Research and Experimental Development, 2015/2016 to 2018/2019.

3.5. R&D HUMAN RESSOURCES

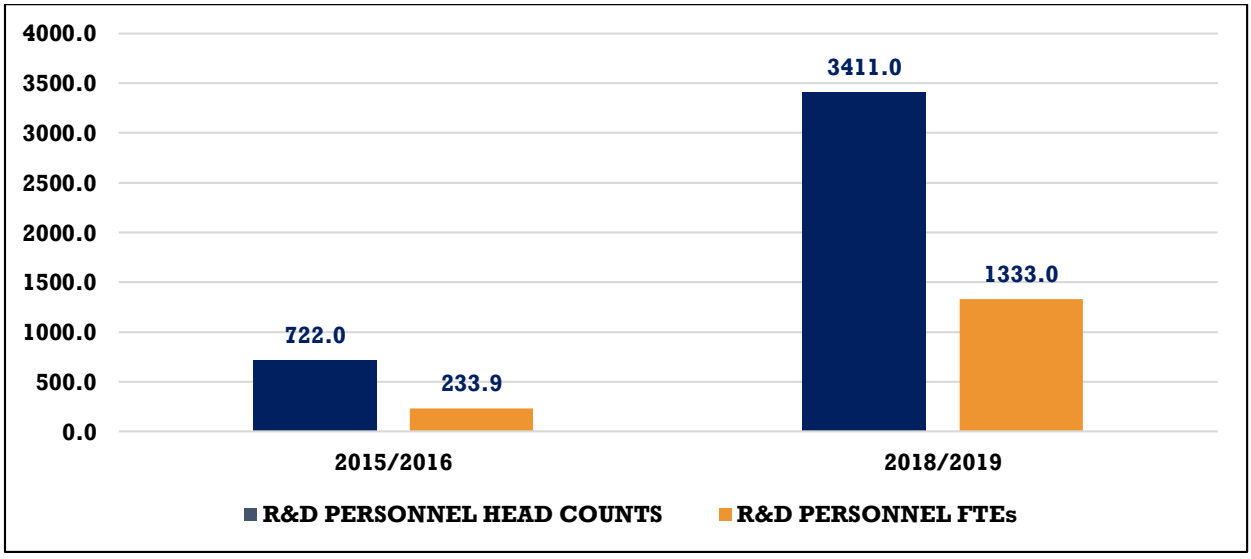
3.5.1. R&D personnel

It is important to estimate the human resources that are available, and actually utilized to do research in the country. In fact, if such resources are not available in sufficient quantities, then it hinders overall performance of R&D.

There has been a notable upward in Rwanda's R&D human resources from 2015/2016 to 2018/2019 in terms of both personnel headcount and full-time equivalents (FTEs).

The R&D personnel headcount increased from 722 in 2015/2016 to 3,411 in 2018/2019. Furthermore, R&D personnel FTEs increased from 233.9 in 2015/2016 to 1,333 in 2018/2019 (Figure 10). This remarkable growth in R&D personnel could be mostly attributed to increased numbers of researchers, as well as the growth in postgraduate student numbers, corresponding numbers of national and international contributors and supervisors in the higher education sector due to centers of excellence and other renowned universities that were established in Rwanda after 2016. This aspect and the existence of R&D institutes and tech business centers could also have contributed to the increase of R&D personnel in the business sector.

Figure 10: R&D personnel (headcount and FTEs), 2015/2016 to 2018/2019



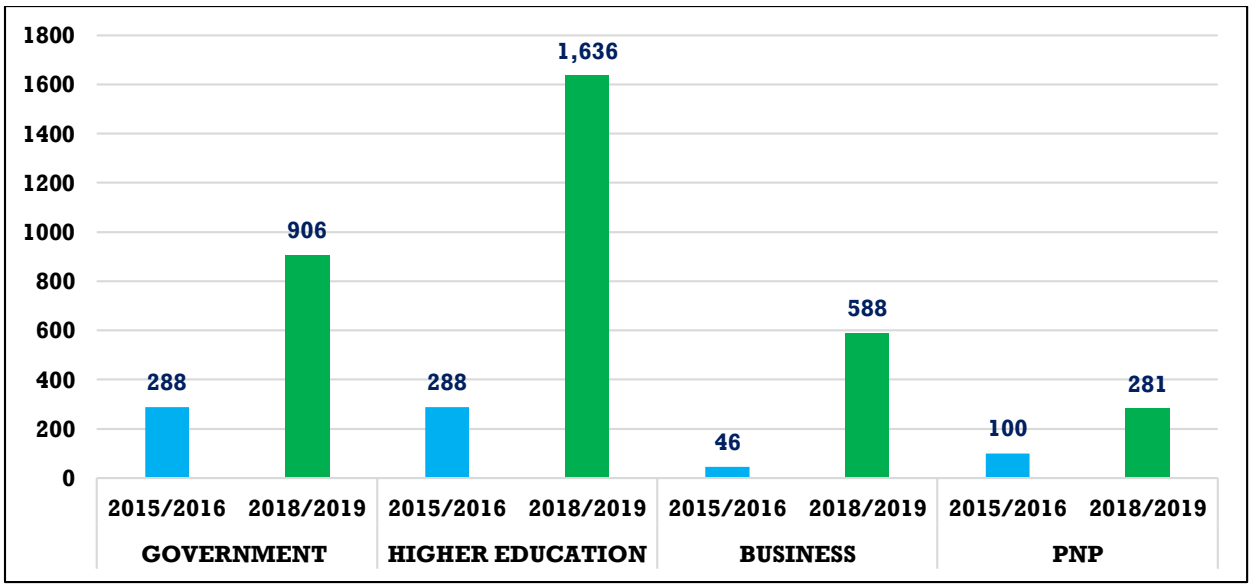
Data notes	R&D personnel headcounts include persons employed by R&D units as well as external contributors. FTE: Full-time equivalent.
Data sources	Rwanda National Survey of Research and Experimental Development, 2015/2016 and 2018/2019.

3.5.2. R&D personnel headcounts and FTEs by institutional sector of performance

The largest proportion of R&D personnel was observed in the higher education sectors, with 1,636 headcounts recorded in 2018/2019. The government, business and PNP sectors recorded 906, 588, and 281 respectively (Figure 11).

The survey established further that among the R&D personnel, the highest number of researchers was also observed in the higher education sector.

Figure 11: R&D personnel headcount by institutional sector of performance, 2015/2016 to 2018/2019



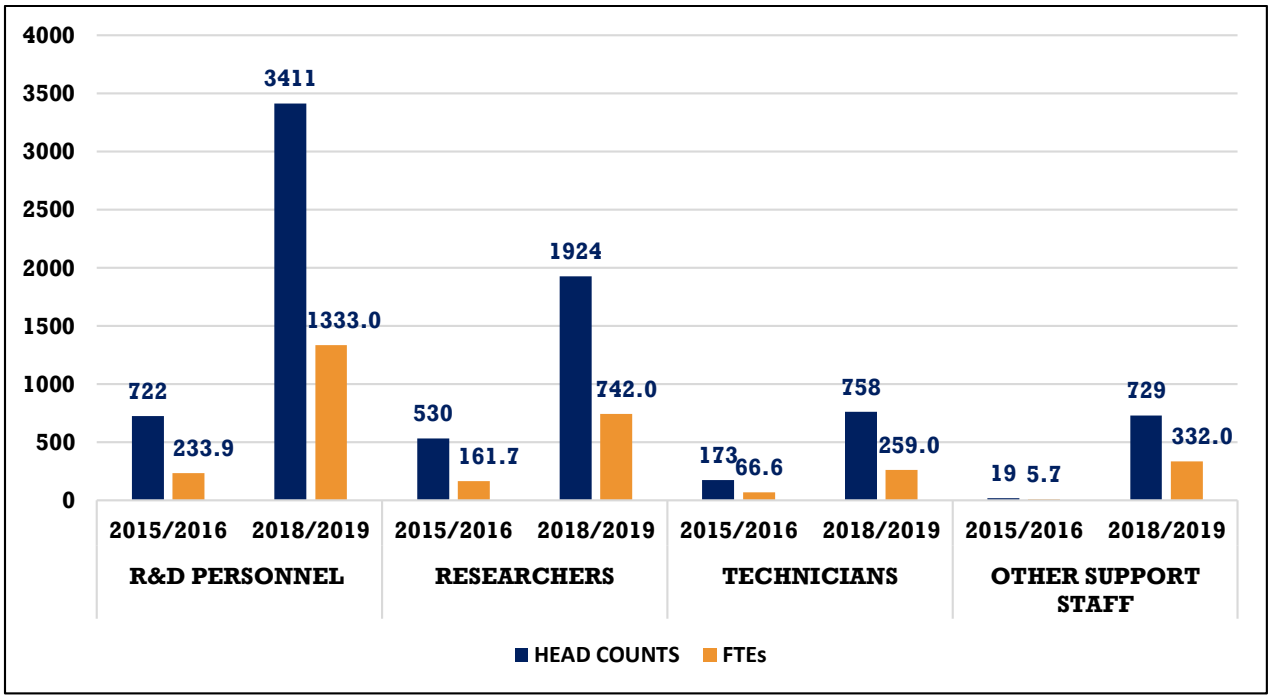
Data notes	R&D personnel headcounts include persons employed by R&D units as well as external contributors.
Data sources	Rwanda National Survey of Research and Experimental Development, 2015/2016 and 2018/2019.

The largest proportion of R&D personnel FTEs was also observed in the higher education and government sectors, with 545 and 478 FTEs recorded in 2018/2019 respectively. The business and PNP sectors recorded 205 and 105 FTEs respectively.

3.5.3. R&D personnel by occupation

The survey established that in 2018/2019, of total R&D personnel across all sectors, researchers accounted for 56.4% (1,924 in headcount), technicians accounted for 22.2% (758 in headcount), and other support staff accounted for the smallest proportion of 21.4% (729 in headcount). In terms of FTEs, researchers accounted for 55.66% (742 in FTEs), technicians accounted for 19.43% (259 in FTEs), and other support staff accounted for 24.91% (332 in FTEs). This profile ratio was also observed in 2015/2016 showing a larger proportion of researchers compared to other categories of occupation (Figure 12).

Figure 12: R&D personnel (headcount and FTEs) by occupation, 2015/2016 to 2018/2019



Data notes	The 2015 Frascati Manual defines 3 categories for R&D personnel occupation: Researchers, Technicians, Other support staff. FTE: Full-time equivalent.
Data sources	Rwanda National Survey of Research and Experimental Development, 2015/2016 and 2018/2019.

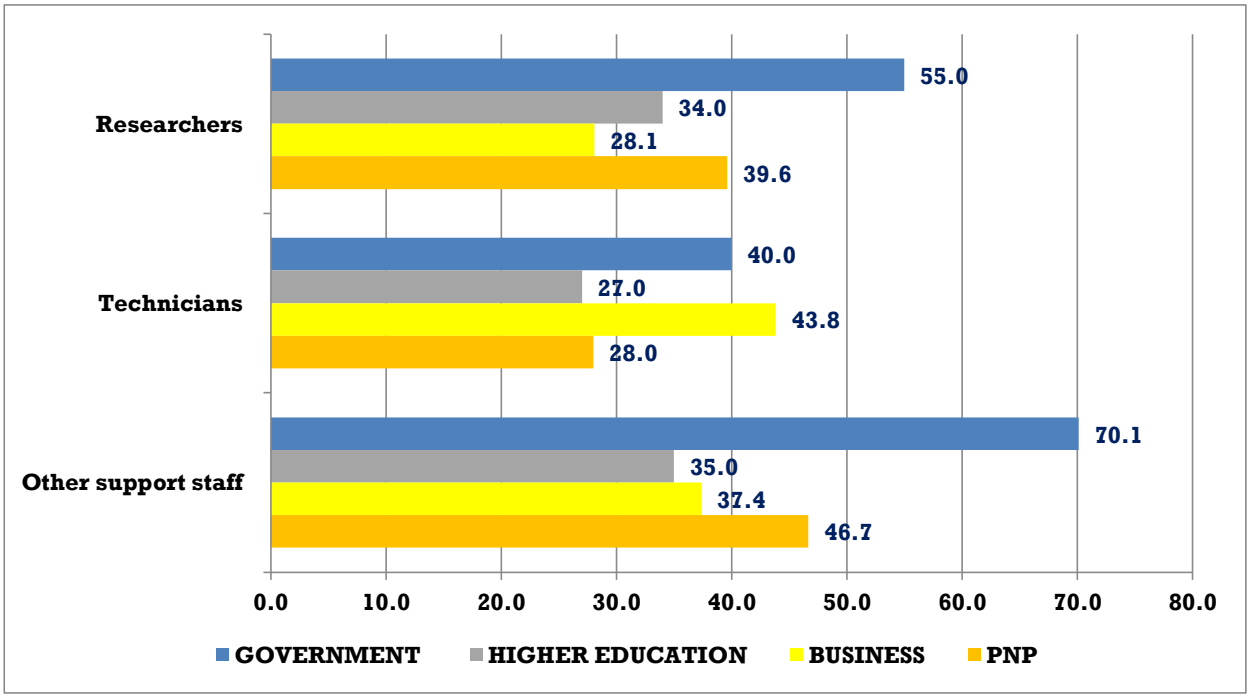
3.5.4. R&D personnel: FTEs as a percentage of headcount

The full time equivalent metric indicates the estimated time that researchers actually spend doing research or are involved in research projects. It also informs on how many people are actually available to perform R&D activities and allocate resources accordingly. Estimates of full time equivalents (FTE) as a percentage of headcount per sector and occupation are shown in Figure 13.

In general, the highest FTEs as percentages of headcounts are observed in the government sector, especially for researchers (55%) and other support staff (70.1%), whereas the highest percentage for technicians is observed in the business sector (43.8%). For the PNP sector, the highest FTEs as percentages of headcounts is for other support staff (46.7%).

The survey established that in the higher education sector, the FTEs as percentages of headcounts is 34%, 27%, and 35% for researchers, technicians, and other support staff respectively.

Figure 13: R&D personnel (FTEs as a percentage of headcount) by sector of performance, 2018/2019



Data notes	The 2015 Frascati Manual defines 3 categories for R&D personnel occupation: Researchers, Technicians, Other support staff.
Data sources	Rwanda National Survey of Research and Experimental Development, 2018/2019.

3.5.5. Women in R&D

Table 8 below shows that there has been a remarkable progress in increasing the participation of women in R&D activities from an overall participation percentage of 25.07% in 2015/2016 to an overall participation percentage of 35.73% in 2018/2018. Accordingly, the survey findings indicated that of the 1,924 researchers across all sectors in 2018/2019, females accounted for 30.4%, also a commendable good progress from 22.64% in 2015/2016. In terms of FTEs, the participation of women in R&D activities increased from an overall participation percentage of 25.05% in 2015/2016 to an overall participation percentage of 41.93% in 2018/2018. Furthermore, the total female research input in terms of full time equivalent is 280 for 585 females; whereas 462 full time equivalent is for 1,339 male researchers (see Table 8).

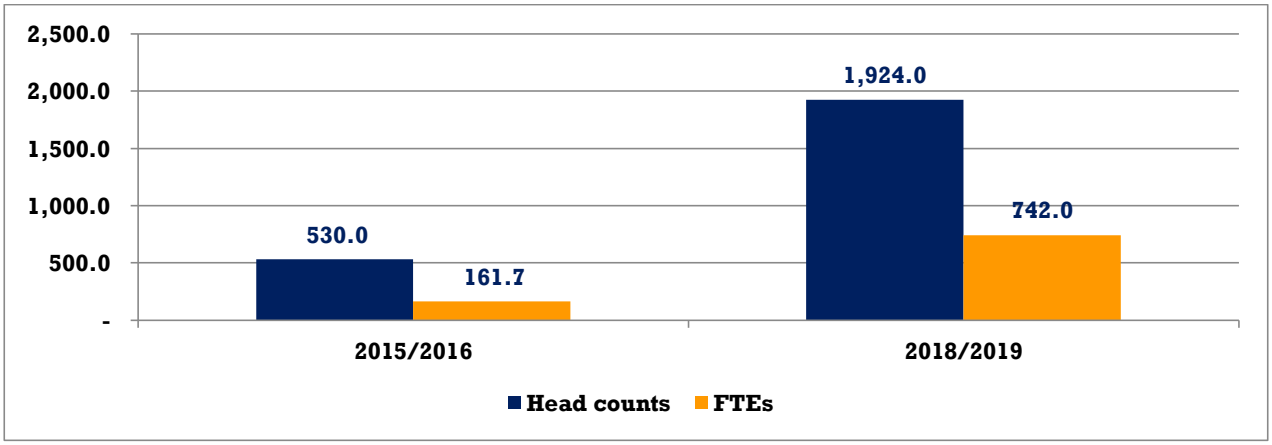
Table 8: Female R&D personnel share 2015/2016 to 2018/2019

Ref. Year/Occupation	Headcounts			Full-Time Equivalents (FTEs)			% of female headcounts (FTEs)
2015/2016	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	
Researchers	530	410	120	161.74	117.2	44.54	22.64 (27.54)
Technicians	173	121	52	66.4	55.5	10.9	30.06 (16.41)
Other support staff	19	10	9	5.66	2.52	3.14	47.37 (55.48)
Total	**722**	**541**	**181**	**233.81**	**175.22**	**58.58**	**25.07 (25.05)**
2018/2019	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	
Researchers	1,924	1,339	585	742	462	280	30.4 (37.73)
Technicians	758	526	232	259	158	101	30.6 (39)
Other support staff	729	327	402	332	154	178	55.14 (53.61)
Total	**3,411**	**2,192**	**1,219**	**1,333**	**774**	**559**	**35.73 (41.93)**

3.5.6. Researchers

Researchers are the driving force in the conception and creation of new knowledge, and the robustness of the National System of Innovation relies on the capacitation of the R&D workforce. In 2018/2019 there was a remarkable increase in researcher headcounts and FTEs. Total researcher headcounts reached 1,924, with 742 FTEs for the same period (Figure 14).

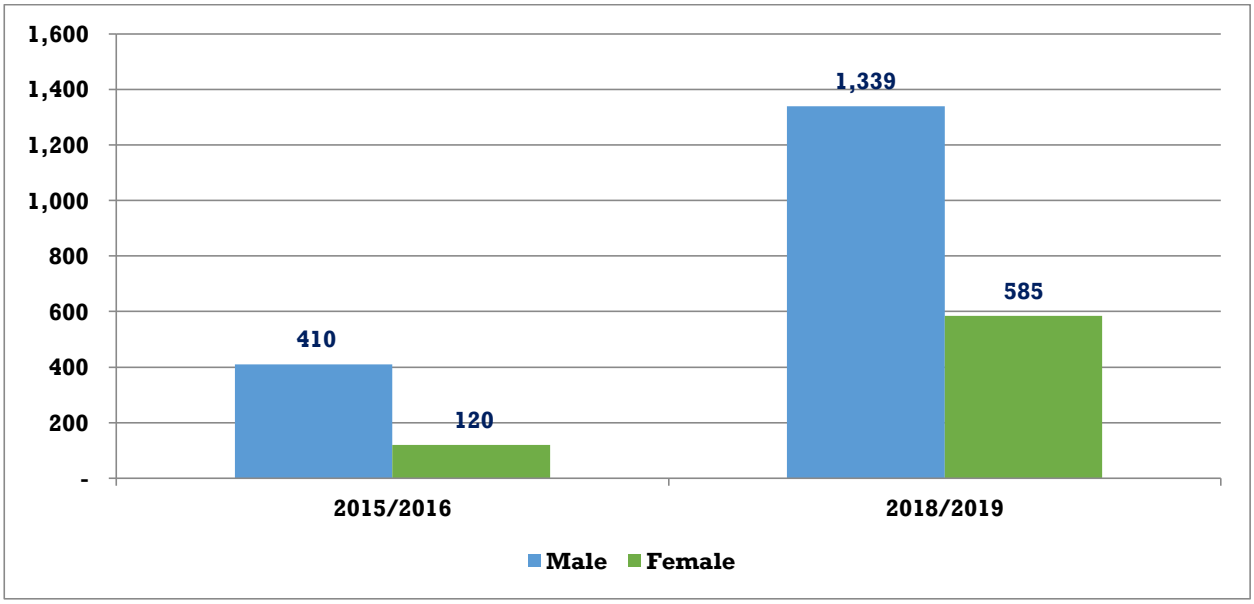
Figure 14: Researchers (headcount and FTEs), 2015/2016 to 2018/2019



Data notes	In higher education, Researcher category research master's students, doctoral students and post-doctoral fellows. Also includes emeritus professors, research fellows and honorary research fellows, as well as external contributors such as supervisors.
Data sources	Rwanda National Survey of Research and Experimental Development, 2015/2016 and 2018/2019.

The percentage share of female researchers amounted to 30.4% of total researcher headcounts and 37.73% of total researcher FTEs (Table 9, Figure 15). Furthermore, in terms of researcher qualification level, the survey established that 25% of researchers hold a Doctoral degree qualification, and 47.09% are at Masters' level. This means that 72.09% of total researchers in R&D have qualifications of a Masters or above. Among technicians and support staff, the majority are at the level of Bachelors' degree or below.

Figure 15: Researchers (headcount) by gender, 2015/2016 to 2018/2019

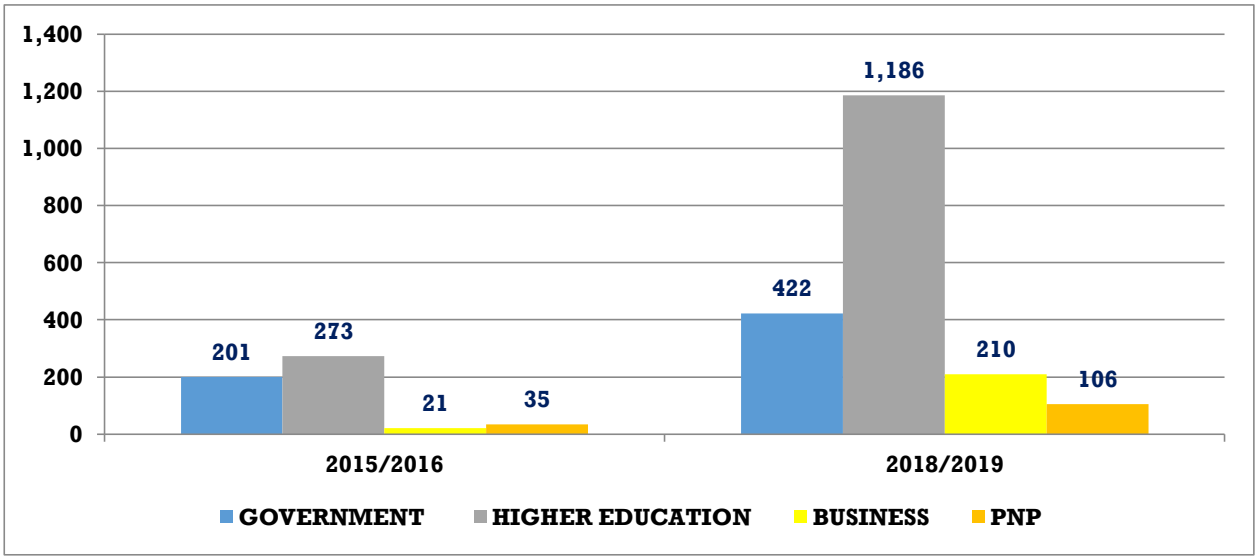


Data notes	In higher education, Researcher category research master's students, doctoral students and post-doctoral fellows. Also includes emeritus professors, research fellows and honorary research fellows, as well as external contributors such as supervisors.
Data sources	Rwanda National Survey of Research and Experimental Development, 2015/2016 and 2018/2019.

3.5.7. Researcher headcount by institutional sector of performance

Disaggregating researcher headcounts into R&D sectors of performance revealed that the highest proportion of researchers of 1,186 in headcount was recorded in the higher education sector (Figure 16).

Figure 16: Researchers (headcount) by institutional sector of performance, 2015/2016 to 2018/2019



Data notes	In higher education, Researcher category includes research master's students, doctoral students and post-doctoral fellows. Also includes emeritus professors, research fellows and honorary research fellows, as well as external contributors such as supervisors.
Data sources	Rwanda National Survey of Research and Experimental Development, 2015/2016 and 2018/2019.

3.5.8. Researcher by field of engagement

The 2015 Frascati Manual classifies the Fields of Research (FORD) as follows: 1. Natural sciences, 2. Engineering and technology, 3. Medical and health sciences, 4. Agricultural and veterinary sciences, 5. Social sciences, 6. Humanities and art sciences and 7. Other (not specified). Data in Rwanda is collected according to these FORD.

Of the 1,924 researchers across all the sectors, Agricultural and veterinary sciences had the highest number of researchers accounting for 21.7% with 417 researchers. Humanities and art sciences had the second highest score account of 19.8% with a count of 381 researchers. The third highest score account of 18.9% was recorded for Medical and health sciences with 363 researches. At number four there was Social sciences with a score of 13.2% with 254 researchers. Engineering and technology and natural sciences recorded the least score account of 11.8% and 9.7% with a count of 227 and 187 researchers respectively (Table 9).

Table 9: Researcher headcounts by research field and sector (2018/2019)

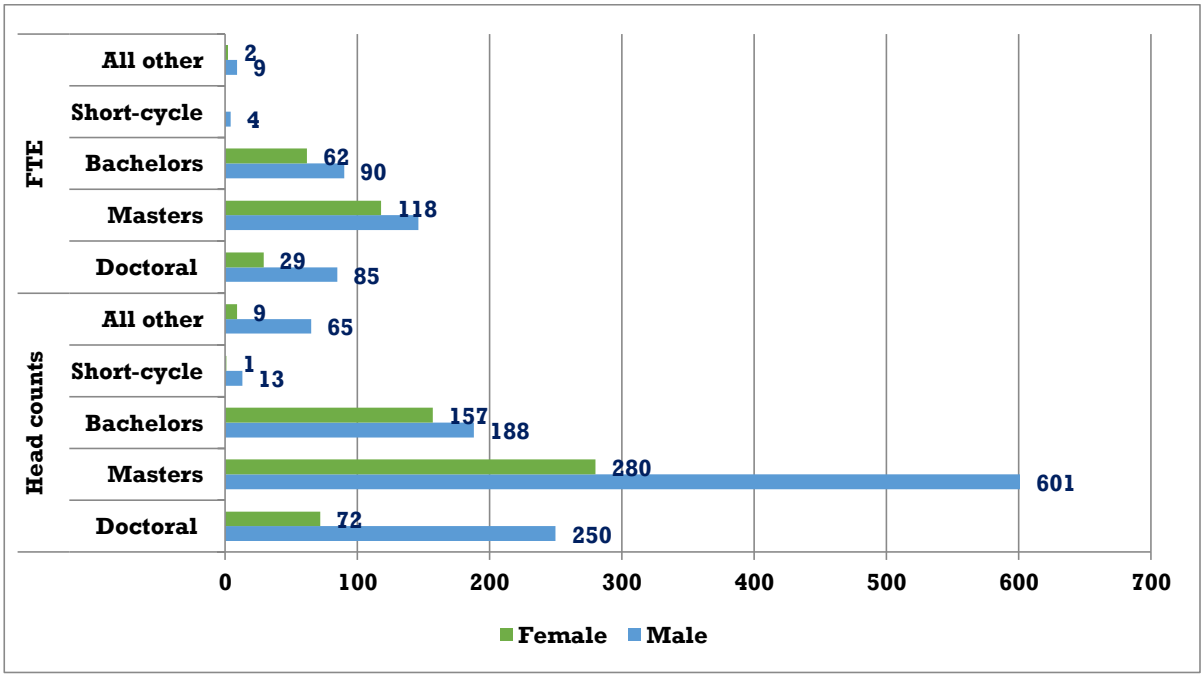
FORD*	Government sector	Higher education sector	Business sector	Private Non-Profit sector	Total (%)
Natural Sciences	42	111	21	13	187 (9.7)
Engineering and technology	49	131	30	17	227 (11.8)
Medical and Health Sciences	54	254	35	20	363 (18.9)
Agricultural and Veterinary Sciences	159	202	42	14	417 (21.7)
Social Sciences	43	163	34	14	254 (13.2)
Humanities and Art Sciences	52	271	39	19	381 (19.8)
Other (Not Specified)	23	54	10	8	95 (4.9)
Total	**422**	**1,186**	**210**	**106**	**1,924**

Data notes	*FORD: Field of R&D
Data sources	Rwanda National Survey of Research and Experimental Development, 2018/2019.

3.5.9. Higher education R&D personnel

The survey established that of the 1,636 R&D personnel in the higher education sector, 19.68% hold a Doctoral qualification. It was also established that 53.85% are at Master's level, meaning that overall 73.53% in higher education R&D personnel have qualifications of a Masters or above. In addition, 21.09% have qualifications of a Bachelor's degree while those with short cycle and all other qualifications account for a small proportion of 5.38%. Figure 17 shows the detailed distribution of higher education sector R&D personnel in headcount and FTE by level of qualification and gender. It is important to note that only 519 accounting for 31.72% of total higher education R&D personnel are women, and only 72 (13.87%) of them hold a Doctoral level qualification.

Figure 17: Higher education R&D personnel (headcount and FTEs) by qualification and gender, 2018/2019



Data notes	The International Standard Classification of Education (ISCED) adopted by the UNESCO Institute of Statistics classifies R&D personnel formal qualification, as follows Doctoral or equivalent level (ISCED level 8) Master's or equivalent level (ISCED level 7) Bachelor's or equivalent level (ISCED level 6) Short-cycle = Tertiary level diploma (ISCED level 5) All other = Post-secondary non-tertiary diplomas and below
Data sources	Rwanda National Survey of Research and Experimental Development, 2018/2019.

3.6. R&D OUTPUT

3.6.1. Research output in publications and intellectual property rights

The current survey provides statistics on the status of R&D output in terms of publications, intellectual property rights and R&D collaboration efforts.

The total R&D output across all sectors for Rwanda in the reference year 2018/2019 was 4,948, all publications and intellectual property rights counted together. Among intellectual property rights, 132 patents were applied for, and 114 granted (Table 10).

Table 10: R&D output by publications and intellectual property rights, by sector of performance (2018/2019)

Outputs	Government sector	Higher education sector	Business sector	Private Non-Profit sector	Total
Publications					
Published books/reports	307	412	98	214	**1,031**
Published papers	120	1185	45	35	**1,531**
Doctoral/Master's thesis	98	298	78	45	**519**
Research awards	6	31	4	1	**42**
Intellectual property rights					
Utility models	14	9	14	13	**96**
Industrial designs	6	5	8	5	**24**
Integrated circuits	4	6	5	0	**15**
Trademarks	11	4	14	11	**40**
Patents	28	37	32	17	**114**
Copyrights	19	35	28	13	**95**
Service marks	12	9	38	21	**80**

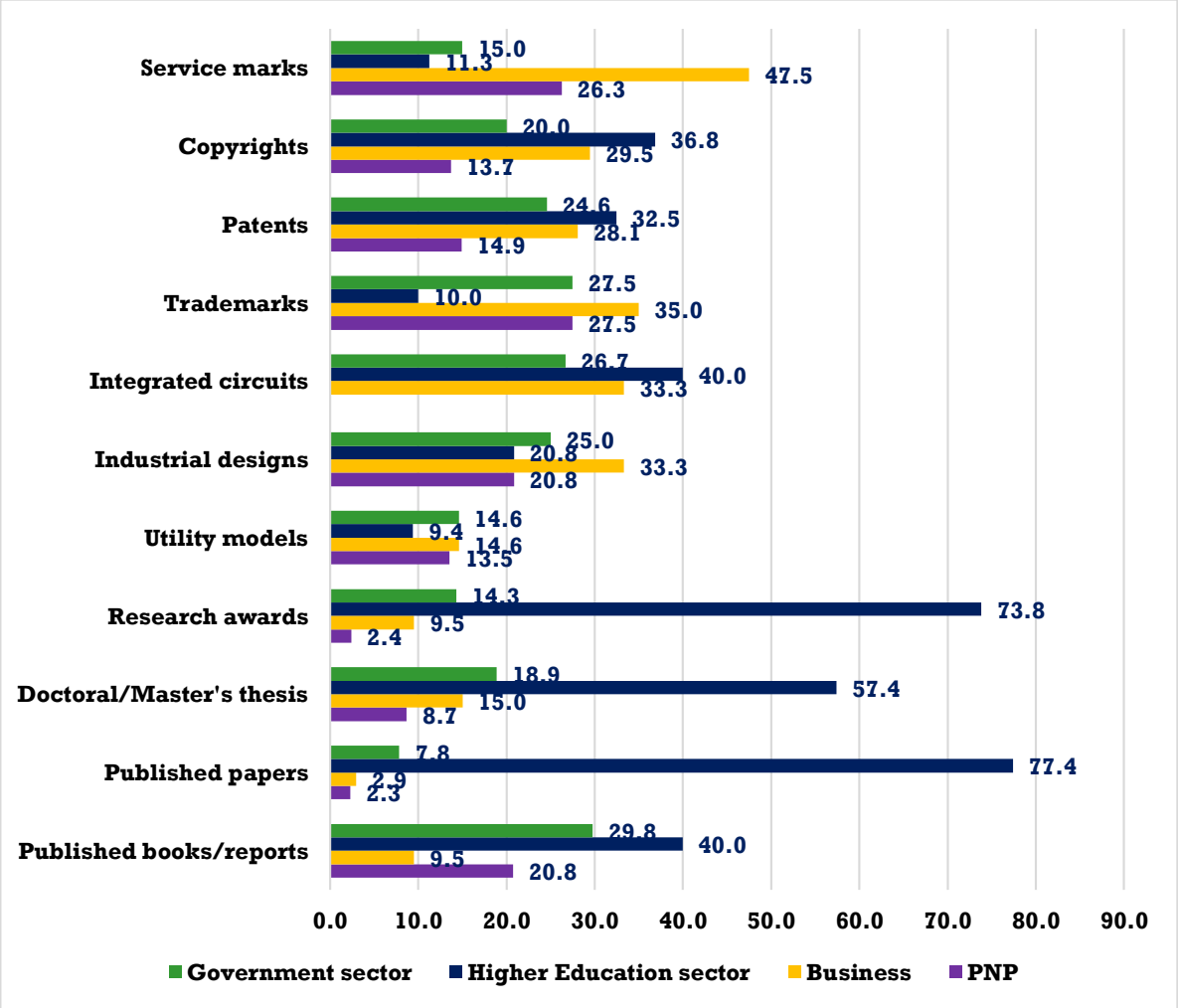
Data sources	Rwanda National Survey of Research and Experimental Development, 2018/2019.

The higher education took the lead in registering the highest proportion of publications. For example, 77.4% of published papers were recorded in higher education sector followed by the government sector at 7.8%, while the business and PNP sectors contributed 2.9% and 2.3% respectively.

In terms of intellectual property rights, among 550 which have been applied for, 464 have been granted. Of the 464 granted intellectual property rights, there were 96 utility models, 24 industrial designs, 15 integrated circuits, 40 trademarks, 114 patents, 95 copyrights, and 80 service marks.

The highest proportion of service marks was registered in the business sector at 47.5% followed by the PNP sector at 26.3%, while the government and higher education sectors registered a contribution of 15.0% and 11.3% respectively (Figure 18).

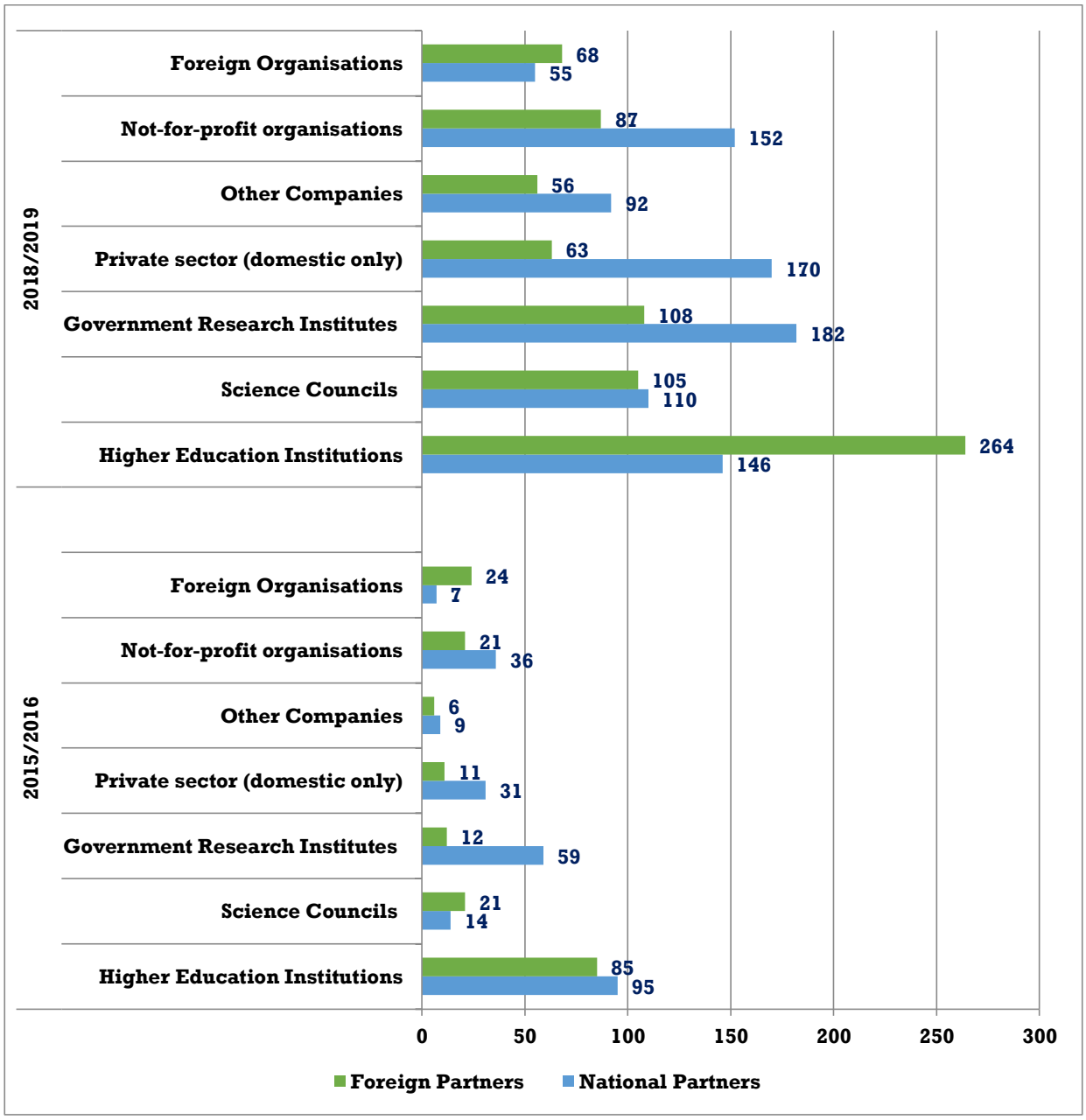
Figure 18: Proportional R&D output by publications and intellectual property rights, by sector of performance (2018/2019)



3.6.2. Collaborative R&D

In terms of collaboration, the survey established that there were more national partnerships in research than foreign partnerships. National partnerships accounted for 54.7% of the total collaborations. The highest national collaboration was among the PNP sector followed by the government sector accounting for 39.36% and 21.83% of all national collaborations counted respectively. On the other hand, the largest foreign collaboration was in the higher education sector followed by the PNP sector accounting for 45.54% and 19.17% of all foreign collaborations counted respectively (Figure 19).

Figure 19: Collaboration efforts – all sectors, 2015/2016 to 2018/2019



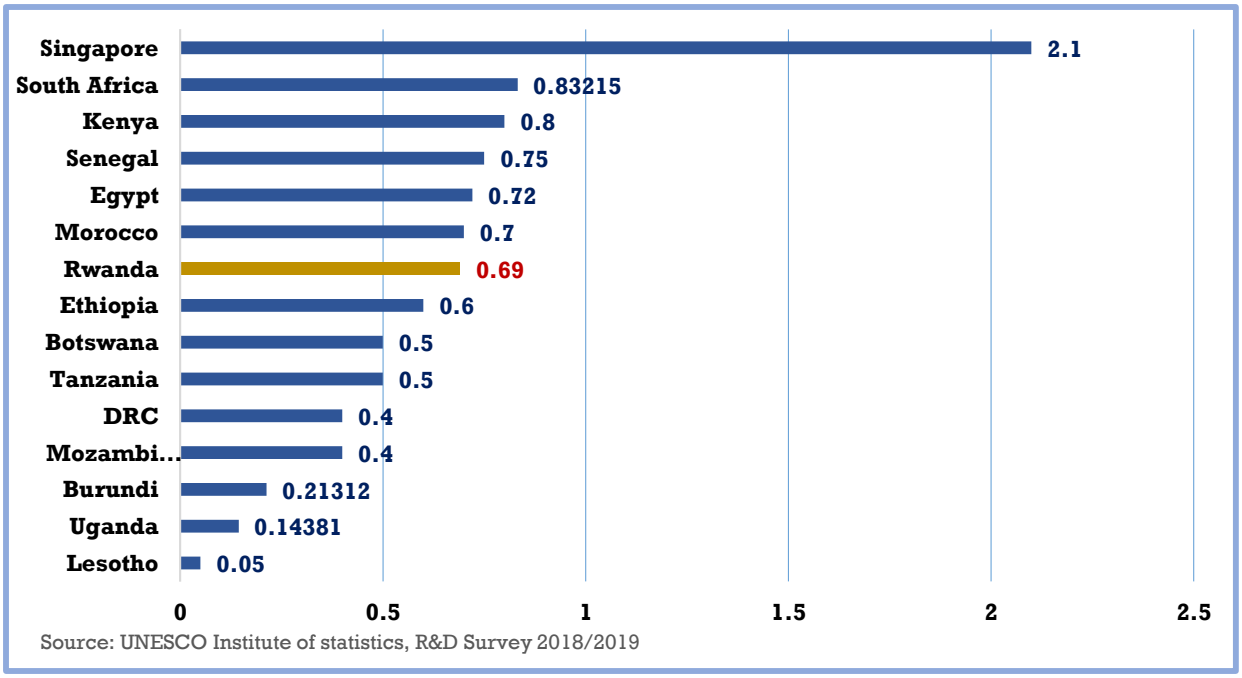
Data sources	Rwanda National Survey of Research and Experimental Development, 2015/2016 and 2018/2019.

3.7. INTERNATIONAL COMPARISONS

3.7.1. Gross domestic expenditure on R&D

For comparison, we look at a sample of some African countries and Singapore. Rwanda's R&D intensity in 2018/2019 was about one third that of Singapore, and was however comparable to that of Morocco. More investment are still required to compare to R&D power houses such as South Africa (Figure 20).

Figure 20: GERD as a percentage of GDP: Sample comparison of some African Countries and Singapore 2018/2019



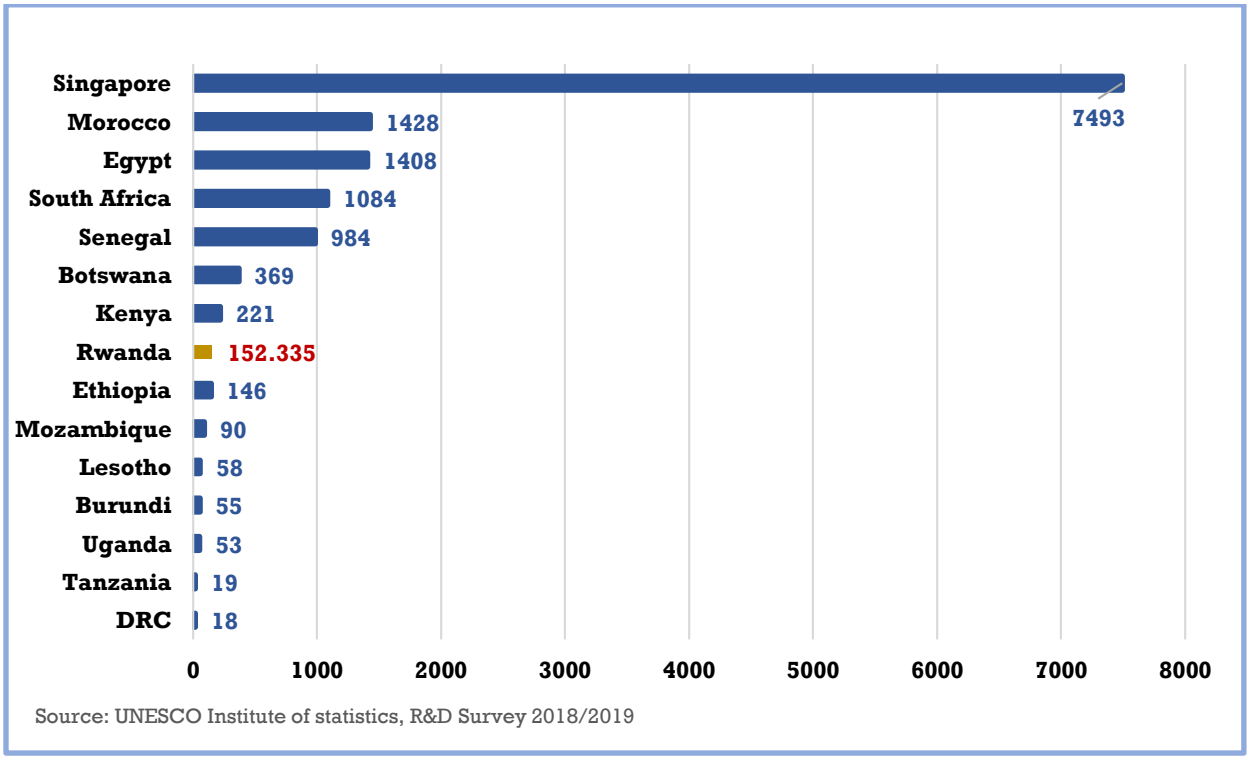
Source: UNESCO Institute of statistics, R&D Survey 2018/2019

Definition	The Frascati Manual (OECD, 2015) defines the R&D-performing sectors as the government, higher education, business and Private Non-Profit (PNP) sectors. The current survey followed this approach in order to maintain consistency with the recommended categorization of institutional sectors.
Data sources	Rwanda: Rwanda National Survey of Research and Experimental Development, 2018/2019. Other countries: UNESCO Institute of Statistics, R&D Survey 2018/2019 or the closest year's reported statistic available at: https://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB http://data.uis.unesco.org/Index.aspx?DataSetCode=SCN_DS&lang=en http://uis.unesco.org/apps/visualisations/research-and-development-spending/

3.7.2. Researcher per 1 million inhabitants for some African countries

With a total of 1,924 researchers, Rwanda has a score of 152.33 researchers per 1 million inhabitants. In this regard, Rwanda still ranks much lower than R&D power houses such as South Africa and Egypt with a score of 1,084 and 1,408 respectively. The countries such as Morocco and Singapore, respectively have a score of 1,428 and 7,493 researchers per 1 million inhabitants (Figure 21).

Figure 21: Researcher per 1 million inhabitants: Sample comparison of some African Countries and Singapore, 2018/2019



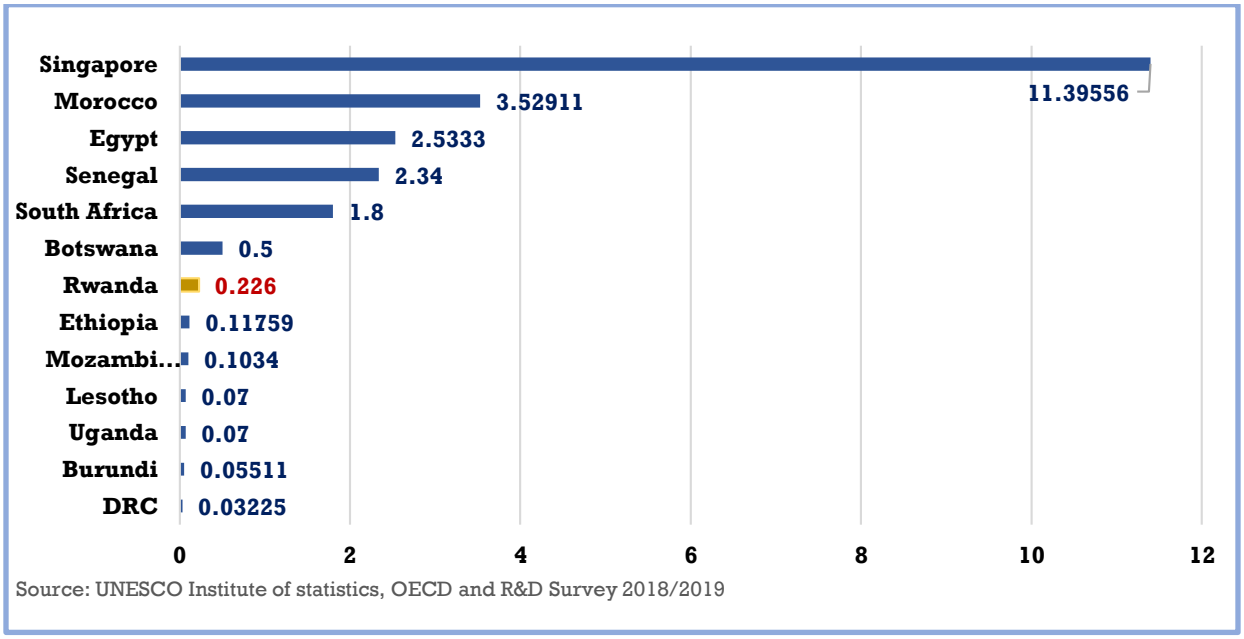
Source: UNESCO Institute of statistics, R&D Survey 2018/2019

Definition	The Frascati Manual (OECD, 2015) defines the R&D-performing sectors as the government, higher education, business and Private Non-Profit (PNP) sectors. The current survey followed this approach in order to maintain consistency with the recommended categorization of institutional sectors.
Data sources	Rwanda: Rwanda National Survey of Research and Experimental Development, 2018/2019. Other countries: UNESCO Institute of Statistics, R&D Survey 2018/2019 or the closest year's reported statistic available at: https://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB http://data.uis.unesco.org/Index.aspx?DataSetCode=SCN_DS&lang=en http://uis.unesco.org/apps/visualisations/research-and-development-spending/

3.7.3. Researcher FTEs per thousand in total employment

With a total of 742 researcher FTEs, Rwanda has a score of 0.226 researcher FTEs per 1 thousand in total employment. In this regard, Rwanda also still ranks much lower than R&D power houses such as South Africa and Senegal with a score of 1.8 and 2.34 respectively. The countries such as Morocco and Singapore, respectively have a score of 3.5 and 11.39 researcher FTEs per 1 thousand in total employment.

Figure 22: Researcher FTEs per thousand in total employment: Sample comparison of some African Countries and Singapore, 2018/2019



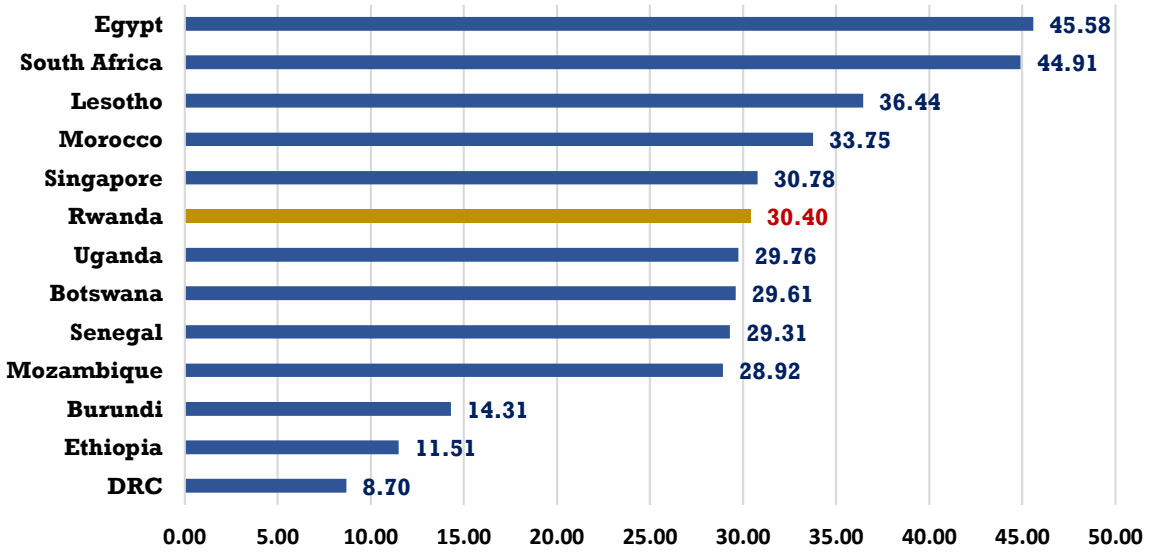
Source: UNESCO Institute of statistics, OECD and R&D Survey 2018/2019

Definition	The Frascati Manual (OECD, 2015) defines the R&D-performing sectors as the government, higher education, business and Private Non-Profit (PNP) sectors. The current survey followed this approach in order to maintain consistency with the recommended categorization of institutional sectors.
Data sources	Rwanda: Rwanda National Survey of Research and Experimental Development, 2018/2019. Other countries: UNESCO Institute of Statistics, R&D Survey 2018/2019 or the closest year's reported statistic available at: https://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB http://data.uis.unesco.org/Index.aspx?DataSetCode=SCN_DS&lang=en http://uis.unesco.org/apps/visualisations/research-and-development-spending/

3.7.4. Female researchers as a percentage of total researchers

In Rwanda, even though progress is still required, a relatively higher proportion (30.4%) of researchers are female compared to most of the African countries. It is apparent that countries that rank higher on other indicators, also rank higher on reducing gender gaps and promoting female participation in R&D activities. For example Singapore and Morocco have a score of 30.78 and 33.75 respectively. In Rwanda however, more efforts are still required to reach a level comparable to that of South Africa at 45.58% (Figure 23).

Figure 23: Female researchers as a percentage of total researchers: Sample comparison of some African Countries and Singapore, 2018/2019



Source: UNESCO Institute of statistics, OECD and R&D Survey 2018/2019

Definition	The Frascati Manual (OECD, 2015) defines the R&D-performing sectors as the government, higher education, business and Private Non-Profit (PNP) sectors. The current survey followed this approach in order to maintain consistency with the recommended categorization of institutional sectors.
Data sources	Rwanda: Rwanda National Survey of Research and Experimental Development, 2018/2019. Other countries: UNESCO Institute of Statistics, R&D Survey 2018/2019 or the closest year's reported statistic available at: https://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB http://data.uis.unesco.org/Index.aspx?DataSetCode=SCN_DS&lang=en http://uis.unesco.org/apps/visualisations/research-and-development-spending/

3.8. SUMMARY

Table 11 summarizes key indicators over the two years from 2015/2016 to 2018/2019, to provide a high-level overview of domestic R&D activity, which has been elaborated on in this report.

Table 11: Summary of key R&D statistics on R&D indicators across the four sectors (2015/2016 and 2018/2019)

KEY INDICATORS	2015/2016	2018/2019
Expenditure on R&D		
Gross domestic expenditure on R&D (GERD) (Rwf)	44,457,113,816	70,601,673,966
Business enterprise expenditure on R&D (BERD) (Rwf)	3,037,310,609	5,599,164,000
Private Non-for-profit (PNP) expenditure on R&D (Rwf)	3,345,227,816	3,887,657,426
Government expenditure on R&D (GOVERD) (Rwf)	34,570,990,942	44,894,051,174
Higher education (HE) expenditure on R&D (HERD) (Rwf)	3,503,584,922	16,220,801,366
Funding sources		
Government-funded R&D (Rwf)	39,503,150,682	40,006,336,644
Business-funded R&D (Rwf)	4,920,088,538	3,392,242,850
Foreign funding of R&D (Rwf)	15,515,315,686	16,915,453,342
Foreign funding of BERD (Rwf)	839,710,000	354,200,000
Foreign funding of PNP R&D (Rwf)	208,040,000	173,810,000
Foreign funding of GOVERD(Rwf)	3, 158,966,208	390,000,000
Foreign funding of HERD (Rwf)	257,396,314	15,997,443,342
R&D personnel		
Total R&D personnel (headcount*)	722	3,411
Total R&D personnel (FTE**)	233.9	1,333
Total researchers (headcount)	530	1,924
Total researchers (FTE)	161.74	742
Female researchers (headcounts)	120	585
Female researchers (FTE)	NA	280
R&D output		
Number of patents applied for	61	132
Number of patents granted	29	114
Number of copyrights applied for	NA	120
Number of copyrights granted	NA	95
Number of projects with national collaborators	252	907
Number of projects with foreign collaborators	180	751
Indicators computed from R&D survey		
GERD as a percentage of GDP (%)	0.66	0.69

BERD as a percentage of GERD (%)	6.83	7.93
Basic research (Rwf)	7,997,834,775	28,395,627,476
Total R&D personnel (FTE) per 1 000 in total employment	0.07	0.407
Total researchers (headcount) per 1 000 000 inhabitants	44.17	152.335
Total researchers (FTE) per 1 000 in total employment	0.049	0.226
Female researcher headcounts as a percentage of total researcher headcounts (%)	22.64	30.4
Female R&D personnel headcounts as a percentage of total R&D personnel headcounts (%)	25.07	35.73
Female R&D personnel FTE as a percentage of total R&D personnel FTE (%)	25.05	41.93
Indicators obtained from external data sources* **		
Gross domestic product (GDP) level at current prices (Rwf)	6,598,550 millions	10,197,900 millions
Total population	11,670,000	12,630,000
Total employment	2,703,000	3,273,921

Data notes	*R&D personnel headcounts include persons employed by R&D units as well as external contributors. **FTE: Full-time equivalent.
Data sources	***GDP, total population and employment statistics are sourced from NISR, World Bank and Worldometers. Rwanda National Survey of Research and Experimental Development, 2015/2016 and 2018/2019.

4. CONCLUSION AND RECOMMENDATIONS

4.1. CONCLUSION

The 2018/2019 R&D Survey was the second nationwide survey undertaken by the National Council for Science and Technology (NCST). The survey covered the four R&D-performing sectors in Rwanda, namely, the government, higher education, business enterprise and private non-profit sectors. This approach was followed in order to maintain consistency with the categorization of institutional sectors recommended by the Organization for Economic Cooperation and Development (OECD) in the Frascati Manual (OECD, 2015), which proposes standard practice for surveys on Research and Experimental Development.

The collected R&D data forms part of the evidence required to inform the status, setting, and performance of policy targets and programs. The analysis of the data also provides useful insights into future initiatives and strategies to address existing gaps.

To evaluate a country's commitment to R&D, essentially we look R&D intensity which is the spending expressed as a percentage of GDP. The R&D survey portrayed that R&D intensity in Rwanda increased slightly, rising by only three basis points from 0.66% in 2015/2016 to 0.69% in 2018/2019. This statistic not only provides insights in contributions from the four sectors, but also provisions for future funding considerations. As such policy makers face a strategic challenge to improve the country's capacity to meet its R&D spending goals in the national drive to realizing a knowledge-based economy.

Another important R&D indicator is the total human resources count which was measured at 3,411 of which 35.73% are women. Of the 3,411 R&D personnel in total headcount across all sectors in 2018/2019, researchers accounted for 1,924 (56.4%) of which females accounted for 30.4%, a fairly commendable increase from 22.64% in 2015/2016. This reflects a significant progress in human capital and impact of efforts put in place to address gaps between male and female R&D personnel. However the country still ranks much lower than most known R&D power houses in Africa and globally. Hence the country's human capital and its research outputs need to increase so that our national system of innovation can contribute optimally to Rwanda's socio-economic development targets.

The survey provides statistics on the respective sources and amounts of R&D funding. Of the total R&D funding, the government funds contributed over half of the overall funding (58%), followed by foreign funds (24.6%), own funds (11.2%), and funds from firms (6.2%). The Government continues to provide public funding that benefit the private sector by supporting partnerships between business, higher education institutions and public research institutions, to stimulate R&D intensity in the country. However, Public-Private sector collaboration needs to be strengthened in order to take advantage of the country's researcher base in a way that stimulates business R&D investment. There is a need to put in place policies that encourage domestic companies to undertake R&D activities. In addition the survey established that higher learning institutions don't have an R&D dedicated budget and mostly relies on foreign funding. In this regard, efforts need to be put in place to stimulate government and business

sectors funding to support the higher education sector which is supposed to lead on the impact of the country's R&D.

The survey also provides statistics on the status of R&D output in terms of publications, intellectual property rights and R&D collaboration efforts. The higher education took the lead in registering the highest proportion of publications. For example, 77.4% of published papers were recorded in higher education sector followed by the government sector at 7.8%, while the business and PNP sectors contributed 2.9% and 2.3% respectively. In terms of intellectual property rights, among 550 which have been applied for, 464 have been granted. Of the 464 granted intellectual property rights, there were 96 utility models, 24 industrial designs, 15 integrated circuits, 40 trademarks, 114 patents, 95 copyrights, and 80 service marks. The highest proportion of service marks was registered in the business sector at 47.5% followed by the PNP sector at 26.3%, while the government and higher education sectors registered a contribution of 15.0% and 11.3% respectively. In terms of collaboration efforts, the survey established that there were more national partnerships in research than foreign partnerships.

4.2. KEY RECOMMENDATIONS

When Research and Development is not given priority, then there is no invention, and there is no innovation, which is otherwise required to drive the socio-economic development of the country. This section is highlighting the key recommendations emerging from the Rwanda National Research and Experimental Development (R&D) Survey 2018/2019.

1. There is a need to continue increasing the overall Gross Domestic Expenditure on R&D (GERD) in order to meet the target of 1% of GDP recommended by the African Union.

2. As Rwanda still ranks much lower in Africa and globally in terms of researcher headcounts, more efforts are required to increase the number of researchers, particularly the number of qualified female researchers in all sectors, especially in the higher education sector to promote equal participation of women and men in performing R&D which leads to increased productivity and better scientific outputs. In this regard, a special funding scheme attracting women is recommended to build the capacity and increase the number of women involved in R&D activities.

3. The country's human capital and its research outputs need to be increased so that the national system of innovation can contribute optimally to Rwanda's socio-economic development targets.

4. Public-Private sector collaboration needs to be strengthened in order to take advantage of the country's researcher base in a way that stimulates business R&D investment. In addition there is a need to put in place policies that encourage

companies to undertake R&D within the country. The government sector should work hand in hand with the private sector by initiating short to medium term R&D projects, while developing long-term R&D strategies. Moreover, there is also a need to increase academia-industry collaboration for the up-take of collaborative R&D projects.

5. The higher education sector is supposed to be at the forefront, lead on the impact of the country's R&D and contribute critically to the country's socio-economic development targets. However, the survey established that about 40% of the higher learning institutions (HLIs) did not perform any in-house R&D during the reference year. Moreover, most of HLIs don't have an R&D dedicated budget and simply rely on foreign funding and donations. In this regard, HLIs need to have an R&D strategy aligned with the country's vision and efforts need to be put in place to stimulate government and business sectors funding to higher education sector R&D.

6. The survey established that about 60% of the government institutions did not perform any in-house R&D during the reference year. In order to increase the R&D up-take in the public sector, there is need for the development of R&D strategy for public institutions.

7. R&D is a valuable tool for growing and improving business. Businesses that have an R&D strategy have a greater chance of success than businesses that don't. An R&D strategy can lead to innovation and increased productivity and can boost the business's competitive advantage. Yet among the surveyed business units, only around 6.21% were found to perform R&D activities. Therefore there is a need to sensitize businesses to develop and implement R&D strategy as well as invest in R&D projects in order to boost business innovations.

8. The benefits of R&D are often long-term, so it's important to remember that investment in it may not result in short-term profits. Therefore the government should advocate for the reduction of interest rate on loans and establish a tax incentive policy on investments in R&D projects for enhancing the related performance and investment by the private sector.

9. The research field of natural sciences, engineering and technology comes last in terms of GERD share. Moreover, this field recorded the least proportion of researchers. There is a need for strategies to promote this field as it is expected to be at the forefront of technological development.

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ANNEX

A1. Dedicated Professionals Ltd team involved in the survey

Name of staff	Position assigned
Dr. Edouard Musabanganji	Dedicated Professionals Ltd, Team leader
Dr. Innocent Ngaruye	Dedicated Professionals Ltd, Senior Researcher/Statistician
Mr. Placide Mukwende	Dedicated Professionals Ltd, Data Manager
Mr. Théoneste Murangira	Dedicated Professionals Ltd, Trainer
Mrs. Pauline Mugeniwangabo	Dedicated Professionals Ltd, Managing Director
ABAYIRINGIRA Josélyne	Enumerator
AKIMANA Velonise	Enumerator
BAKEKA Diane	Enumerator
BASUNIKA Fidele	Enumerator
BUGINGO Jean Claude	Enumerator
DUSABE Louise	Enumerator
FISTON Ramutsa	Enumerator
GABA Egide	Enumerator
NKAKA Germain	Enumerator
MUTIHEBA Gilbert	Enumerator
GIRAMATA Ange	Enumerator
HABIMANA Béatrice	Enumerator
HABIMANA Jean d'Amour	Enumerator
HABINEZA Emmanuel	Enumerator
HABINGABO Alain	Enumerator
IMANIZABAYO Gloriose	Enumerator
INGABIRE Sylvia	Enumerator
IRUMVA Peter	Enumerator
ISANGE Sine Nadia	Enumerator
ISHEJA Emmanuel	Enumerator
ISHIMWE Christian	Enumerator
IYAKAREMYE Jean de la Croix	Enumerator
KABERUKA Védaste	Enumerator
KADARI Etienne	Enumerator
KAMBOGO Christella	Enumerator
KAMBOGO Regine	Enumerator

KAYITESI Grace	Enumerator
KOMEZUSENGE Delphine	Enumerator
MUKASEKURU Julienne	Enumerator
MUKESHIMANA Gaudence	Enumerator
MUNEZERO Arianne	Enumerator
MUNEZERO Blandine	Enumerator
MUPENZI Hertier	Enumerator
MUTIJIMA Patrick	Enumerator
NDAGIJIMANA Desire	Enumerator
NDAYIZEYE Regis	Enumerator
NGABONZIZA Rodrigue	Enumerator
NIWEMFURA Marie Jose	Enumerator
NSABIMANA Védatse	Enumerator
NYANDWI Innocent	Enumerator
NYIRAJAMBO Dina	Enumerator
NYIRANEZA Valentine	Enumerator
RUGAMBA Aimable	Enumerator
RUGIRA silas	Enumerator
RUKUNDO August	Enumerator
RURANGWA Viateur	Enumerator
SANGWA Marie Belise	Enumerator
TUYISENGE Claude	Enumerator
TUYISHIMIRE Eliane	Enumerator
TUYUMVIRE Neema	Enumerator
UMUHOZA Solange	Enumerator
UMULISA Ruth	Enumerator
URINZWENAYO Bertin	Enumerator
UWAMBAYE Claudette	Enumerator
UWERA Angélique	Enumerator
UWITONZE Fulgence	Enumerator
UWIZEYIMANA Josiane	Enumerator