

APPENDIX 1: UNIVERSITY OF RWANDA RESEARCH CLUSTERS

Introduction

UR has organized its 5-year plan for research training and capacity building activities into **10 interdisciplinary research clusters** derived from emerging national and sectoral priorities aligned with national development goals (e.g., Capacity Development and Employment Services Board, Vision 2020), the UR strategic plan, College plans, and the SDGs. These clusters are supported by cross-cutting themes of environmental and gender sensitivity, as well as innovation and knowledge transfer.

The global socio-economic challenges related to energy, water, climate, food, and health require joint efforts from the natural, physical and social sciences for the development of comprehensive solutions that integrate relevant insights and perspectives. To contribute to addressing Rwanda's complex challenges, UR will transition to an interdisciplinary approach, understood as an *integration* of different disciplines to tackle a problem. Interdisciplinary research allows for a research problem or topic that is too broad or complex to be dealt with adequately by a single discipline to integrate multiple disciplinary perspectives for a more comprehensive outlook. It may range from the borrowing of concepts from other disciplines to highly close interdisciplinary team collaboration. Furthermore, creating a highly interdisciplinary and integrative institutional culture has been shown to encourage breakthrough discoveries and innovation. Interdisciplinary research is therefore the approach to be taken in developing research teams and niches.

Research Cluster 1: Agricultural transformation and food security

This cluster will address research needs for sustained transformation of Rwanda's agricultural systems not only from agricultural scientists, but also an interdisciplinary approach including social scientists, engineers, economists, nutritionists, hydrogeologists, and ecologists. While Rwanda has realized significant improvements in crop yields, levels of productivity are still below international standards, and climate change and crop diseases place stressors on agriculture systems and food security in Rwanda. Similarly, a large fraction of farmers still apply unsustainable agricultural practices due to low technology uptake and adoption.

Key areas to address these gaps include: genetic enhancement of food resources, nutrition, irrigation, soil erosion studies, land characteristics, groundwater use and management, farm productivity, sustaining the natural resource base upon which production of plant and animal production depends, reducing postharvest losses, development of horticulture, post-harvest technologies, and food engineering, value chains and entrepreneurship development. Developing collaborative research engaging farmers and integrating farmer context in the research setting will constitute a more efficient strategy for technology testing and uptake, with attention to the behavioral change needed for farmers to adapt.

Research Cluster 2: Socio-Economic Transformation and Sustainable Development

Rapid changes in Rwanda are transforming livelihoods and presenting opportunities to design equitable and sustainable future for the people. This cluster will focus research on understanding the drivers of structural transformation and socio-economic effects on livelihoods. Topics include the relative contribution of manufacturing to GDP, declining shares of agricultural employment to total employment, rural to urban shifts, youth unemployment, climate change impacts on socio-economic systems, and emergence of modern industrial and service economies.

Research Cluster 3: Environment, Natural Resources Management and Climate Change

Rwanda's development goals, in addition to the nature of today's modern society, create opportunities, demands, and threats to the environment (e.g., urban development, consumption patterns). Rwanda aspires to be a leader in environmental protection, biodiversity conservation and climate change resilience as a platform for green investments embedded in its poverty reduction strategy (EDPRS II). Research in

this cluster will focus on sustainable natural resources management, biodiversity conservation, climate change science and environmental monitoring and change detection. Innovative approaches to monitor wildlife, reduce threats to biodiversity and sustain the provisioning of ecosystem services are needed. Climate change is affecting patterns of rainfall, disease outbreaks, and temperature regimes, resulting in flooding, erosion, droughts, food insecurity, and loss of life. Understanding and predicting these changes is crucial to economic transformation goals. Furthermore, Rwanda's reserves of methane, gold, tantalum, and other deposits, and its forestry resources are valuable to national development goals, and best practices to access these resources safely and sustainably are needed. Research needs include the application of geology for identification of efficient mine types, and environmental impacts of new mining or forestry operations in Rwanda.

Research Cluster 4: Inclusive Governance, Peace and Security

Rwanda's Vision 2020's first pillar is good governance and a capable state. Both Vision 2020 and Vision 2050 aim at turning Rwanda into a knowledge-based economy, characterized by effective governance, rule of law and respect for human rights and fundamental liberties. A landmark aspect of effective governance in Rwanda has been the introduction of home grown solutions that enhance the role of citizen participation in governance and economic development. Rwanda's effectiveness in the restoration of peace after the Genocide against Tutsi in 1994, its anticorruption achievements, and its contribution to international peacekeeping indicate the strides in the last 20 years. Rwanda is currently considered the most efficient government in Africa. In this cluster, research will include prescriptive and predictive conflict management, governance as a method of social conflict resolution in non-violent and deliberative pathways, and governance as a central pivot in transformation and peacebuilding.

Cluster 5: Urbanization, Green Cities, and Human Settlements

This cluster focuses on processes of urbanization and human settlement that meet Rwanda's development strategies including environmental sensitivity. Although Rwanda's urbanization rate is among the lowest in the world, the annual growth rate of the urban population (4.5%) far exceeds the worldwide average of 1.8%. Almost half of the urban dwellers are concentrated in the City of Kigali. Urbanization is challenging for such a small and densely populated country, exerting pressure on water, sewage, the living environment, and public health, which disproportionately affect the urban poor. Without good planning, urbanization leads to sprawl and marginalization, which is socially divisive and increases energy demand, carbon emissions and ecosystem degradation.

Implementation of green city plans brings to the fore many critical research questions including how urban planning strategies can reduce a city's vulnerability to climate change; adaptation of urban governance systems; and identification of innovative institutional solutions. Recently, Rwanda initiated the Smart Green Villages concept with the aim of supporting practices for integrated food, water and energy self-sufficiency for sustainable living among the rural poor and vulnerable. Rwanda's National Urbanization Policy 2015 explicitly calls for enhanced collaboration between public and private institutions, civil society, and academia in creating sustainable urban habitats.

Priority research areas include improved urban and rural settlements development, planning and management systems; financing and supply options for affordable housing; institutional and human capacity development in urban and rural settlements; and geohazard mapping to identify exclusion areas for urban growth.

Cluster 6: Transformative ICT and Knowledge Management

Information and communications technology plays a major role in transforming the economy, and are integral to achieving Rwanda's Vision 2020 and 2050 goals. The focus of research in this cluster will be on software engineering, cyber security, mobile app development, smart city and sustainable urban development, E-commerce and E-banking, E-health and telemedicine, IoT, among others.

Research Cluster 7: Health and Wellbeing for All

The health and wellbeing of Rwanda's people underpin its national strategies and targets. While Rwanda has made tremendous progress in maternal and child health, and prevention and control of communicable diseases, the country is faced with rapidly increasing incidences and deaths due to non-communicable diseases. The broad research areas in this cluster will include nutrition, environment health, One Health approach, communicable and non-communicable diseases, climate change effects on disease occurrence, community health systems, and maternal and child health.

Research Cluster 8: Sustainable Energy and Manufacturing

This cluster has two of the most crucial, emerging sectors of the Rwandan economy, flagged in the Science and Technology Policy (2016), the Capacity Building and Employment Services skills gap analysis (2015), and representing core STEM areas. Affordable, reliable, and sustainable energy for all is considered an important component in the transformation of people's lives. A building block for quality of life under Rwanda's Vision 2050 is affordable, sustainable, reliable and modern energy. Rapid economic growth in Rwanda has put pressure on energy use and demand. On sustainable energy the research focus will be on various aspects related to increased access to modern energy such as micro-grids using solar, micro-hydropower, wind, and geothermal.

Similarly, the manufacturing sector in Rwanda is small but growing steadily at 7% per year. Manufacturing is being promoted as a rapid pathway to economic and structural transformation. The 'Made in Rwanda' campaign to promote consumption of locally manufactured items is evidence for the growing importance of this cluster. Policies such as the National Industrial Policy and the National Export Strategy aim to accelerate manufacturing and export growth. In manufacturing areas of research will address civil, chemical, electric and environmental engineering at all levels, including industrial process engineering, operational research applied to industry, quality assurance and management systems, automation of industrial processes, product engineering, and 3-D printing.

Research Cluster 9: Transformative Education, Culture and Creative Arts

This cluster is embedded in the humanities and social sciences, and contribute to the economic transformation of the country. Rwanda's flagship development policies (Vision 2020, Vision 2050, EDPRS 2) highlight the importance of education in transforming societies. Rwanda has made tremendous progress in democratizing education and ensuring its access to all, but still grapples with issues of quality which need to be researched to adequately inform policies and strategies. Rwanda's embrace of home grown solutions to address economic challenges has shown how culture can be used as a driver of rapid development. Efforts such as sustaining Rwandan core values of self-sufficiency (kwigira) and solidarity and dignity (Agaciro) show how non-STEM disciplines can be rallied to drive economic transformation. Arts and culture also represent an important potential for business opportunities. Yet research on the role of arts and culture is limited.

Research Cluster 10: Transport and Logistics

Transport is key to economic transformation, and has been identified as a key sector for long term prosperity in Rwanda, driving the shift from a landlocked to land-linked position. An efficient transport system is crucial for the development of a modern society that supports healthy and sustainable living for all people. Although Rwanda is noted for the best business environment in Africa, challenges in the transportation sector exist, including high transport costs, over dependency on internal networks, a nascent aviation industry, lack of a railway system, limited application of IT to transport and logistics, limited supply chain skills, and a low number of transportation and logistics specialists. This cluster addresses research needs in logistics and transport in interconnected systems (road, air, water, railway), transportation engineering, SMART mobility and transport modelling.

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