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HEIGHTS-IE: HIGHER EDUCATION INSTITUTIONS GENERATING HOLISTIC AND TRANSFERABLE SOLUTIONS – INNOVATION ECOSYSTEMS, KENYA

FINAL REPORT

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ABBREVIATIONS

AFC	Agricultural Finance Corporation
ATIE	AgriTech Innovation Ecosystem
CBK	Central Bank of Kenya
CBO	Community-Based Organization
CGIAR	Consultative Group for International Agricultural Research
CoELIB	Centre of Excellence for Livestock Innovation and Business
CSO	Civil Society Organization
CUE	Commission for University Education
GDP	Gross Domestic Product
GII	Global Innovation Index
GIZ	German Corporation for International Cooperation
GMO	Genetic Modified Organism
HDA	Horticultural Development Authority
HEI	Higher Education Institution
IP	Intellectual Property
IT	Information Technology
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KALRO	Kenya Agricultural and Livestock Research Organization
KEBS	Kenya Bureau of Standards
KEMFRI	Kenya Marine and Fisheries Research Institute
KeNIA	Kenya National Innovation Agency
KEPHIS	Kenya Plant Health Inspectorate Services
KFA	Kenya Farmers' Association
KIDRI	Kenya Industrial Research and Development Institute
KII	Key Informant Interview
KTDA	Kenya Tea Development Agency
LMICs	Low- and middle-income countries
MoE	Ministry of Education
MoU	Memorandum of Understanding
NACOSTI	National Commission for Science, Technology and Innovation
NGO	Non-governmental Organization
NRF	National Research Fund

PI	Principal Investigator
PPP	Public Private Partnership
TVET	Technical and Vocational Education and Training
STI	Science, Technology and Innovation
RQ	Research Question
UoN	University of Nairobi
USAID	United States Agency for International Development
WIPO	World Intellectual Property Organization

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EXECUTIVE SUMMARY

REPORT PURPOSE

This study presents evidence on how higher education institutions (HEIs) in Kenya engage in the AgriTech Innovation Ecosystem (ATIE) to inform the Higher Education Learning Agenda of the United States Agency for International Development (USAID). The research is part of a multicountry comparative study involving Kenya, Indonesia and the Philippines, which explores the following question: What lessons can be derived from analyzing the involvement of HEIs in LMICs in specific local and regional innovation ecosystems that could inform policies and strategies to enable LMIC HEIs to engage more effectively in and strengthen national and/or subnational innovation ecosystems?

This study draws from the lessons derived by analyzing the involvement of HEIs (principally universities) in the ATIE to inform policies and strategies that enable their effective engagement and strengthening of the ATIE. Specifically, the study explores how HEIs can engage more effectively in and strengthen the ATIE in Kenya. The eight research questions are detailed in the key findings sub-section below.

Qualitative research methods were used to capture the relevant information from key stakeholders including representatives from HEIs (faculty, staff and students), the private sector, the civil society, national and county government ministries, government agencies, entrepreneurs, and economic development agencies.

KEY FINDINGS

RQ1: WHAT ARE ECOSYSTEM ACTORS' PERCEPTIONS OF THE PURPOSE, FUNCTIONALITY, AND LEVEL OF DEVELOPMENT OF THE AGRITECH INNOVATION ECOSYSTEM (ATIE) IN KENYA?

This research question sought views on why the ATIE exists (its purpose), how it functions and its operational efficiency in achieving its intended goal.

Purpose of the ATIE

The ATIE plays a big role in improving agricultural productivity and food security as well as promoting agribusiness through various innovations, processing, and marketing of agricultural products. HEIs within the ATIE are involved in the development of new crop varieties and innovations in machinery and other equipment. In addition, the HEIs address information gaps in agribusiness mainly through knowledge generation, translation, and information transfer to actors within the ATIE.

Functionality of the ATIE

The ATIE has several actors that collaborate on research and innovations and interact at different levels, namely international, regional, and national. The interactions of the actors range from collaborative or joint activities such as conferences, workshops, research projects, partnerships, curriculum delivery as well as funding research. Through partnerships and collaborations, actors pool together expertise and resources. However, there are important barriers to these actors' efficient and effective collaboration, including bureaucratic barriers to collaboration between HEIs, inadequate policies for establishing HEI-private sector collaborations, and poorly staffed innovation offices to link HEI-produced innovations to the private sector for commercialization.

Level of development of the ATIE

Views expressed on the level of development of the ATIE ranged from underdeveloped to medium. Respondents noted that the development of the ATIE varies by sector, with sectors like the seed industry, pest control, and Information Technology (IT) being relatively well developed, while water management, agricultural processing, and livestock sectors were mentioned to be lagging. The medium level of development of the ATIE is attributed to factors such as availability of robust research and innovation opportunities, technical capacity of the HEI faculty, a thriving private sector, availability of funding and investment, and the presence of diverse actors within the ecosystem. On the other hand, the progress of the ATIE faces several challenges including: (1) low levels of dissemination/awareness, adoption, and commercialization of AgriTech research and innovations; (2) low government interest; (3) weak intellectual property protection; (4) insufficient promotion of traditional knowledge-based technologies; (5) low levels of innovation culture among actors especially HEI faculty; and (6) low industrial development.

RQ2: WHAT ROLES ARE HEIs IN THIS STUDY CURRENTLY PLAYING IN THE ATIE?

The study findings show that HEIs play three main roles in the ATIE which are in alignment with USAID's Higher Education Program Framework. These include skilling and developing human capital, fostering research and innovation, and translating and disseminating knowledge.[1]

Skilling and developing human capital

HEIs contribute to the skilling and the development of human capital for the ATIE's workforce by educating and mentoring students in agricultural and related fields, and conducting community outreach activities targeting farmers.

Fostering research and innovation

HEI faculty and students undertake research that leads to innovations within the ATIE. Older public universities in Kenya are well known for research in plant and livestock breeding, processing of agricultural products, development of soil and water management technologies, and development of drought and disease-resistant crop varieties.

Translating and disseminating knowledge

HEIs contribute to the enhancement of knowledge by translating and communicating such findings to stakeholders within the ATIE through publications, conferences, workshops, innovation weeks/fora, webinars, community outreach, mass media, social media, and digital platforms, among other channels.

[1] This corresponds with one of the HEI core functions (engage and strengthen networks and communities) as illustrated in USAID's Higher Education Program Framework.

RQ3: WHAT IS THE LEVEL OF COORDINATION AND PARTNERSHIP BETWEEN KEY ACTORS IN THE HEIs UNDER STUDY AND THE ACTORS ENGAGED IN THE ATIE?

HEIs partner and collaborate with other actors in the ATIE on various activities including training, mentorship, idea incubation, research, fundraising, joint outreach activities, communication of research and dissemination of innovations.

Partnerships amongst HEIs

HEIs within the ATIE partner and collaborate in several areas, including capacity strengthening of staff, faculty, and students; training; joint research collaborations; and benchmarking visits. However, findings from this study show that effective coordination, collaboration, and partnership within and between HEIs is affected by institutional bureaucracies with many of the faculty opting to work in silos to save time.

Partnerships between HEIs, the government and its agencies

HEIs are mandated through policy to work with government ministries and agencies within the ATIE. These partnerships serve various purposes including access to expertise, facilitating funding, dissemination of innovations by both HEIs and government agencies, supporting patenting of innovations, enforcing standards by government agencies, incubation and commercialization of innovations, and community outreach.

Partnerships between HEIs and public research organizations

Partnerships between HEIs and public research institutions within the ATIE are driven by the needs of the partnering institutions. Such partnerships play various roles including facilitating access to teaching and research facilities, provision of expertise, resource mobilization, dissemination of research and innovations, staff and student exchanges, internships and attachments, networking, and industrial linkages.

Partnerships between HEIs and the private sector

Study findings reveal that some level of partnership exists between HEIs and the private sector actors, such as farmers, industry, and financial institutions in areas of mechanization of agricultural processes,

development and testing of prototypes, commercialization of innovations, and community outreach services. However, due to inadequate or lack of policies and frameworks for engagement, partnerships with the private sector do not work effectively.

Partnerships between HEIs and development partners

Strong partnerships exist between HEIs and international development partners, such as USAID, European Union, World Bank, Japan International Cooperation Agency, and the German Corporation for International Cooperation. Such partnerships involve student scholarships, exchange programs, research funding, capacity strengthening, and support toward infrastructure and equipment.

Partnerships between HEIs and civil society

Findings show that some partnerships between HEIs and CSOs exist for various activities, including student exchange programs (attachments and internships); training and research; and joint workshops, conferences, seminars, and innovation exhibitions, exist.

RQ4: WHAT RESOURCES DO THE STAKEHOLDERS AT THE HEIs INCLUDED IN THE STUDY NEED TO BE ABLE TO ENGAGE EFFECTIVELY IN THE ATIE IN KENYA?

To effectively participate in the AITE, HEIs need stronger human resource capacity, infrastructure and equipment, institutional initiatives and frameworks, and financing.

Stronger human resource capacity

HEIs, especially the public ones, need an adequate number of trained faculty and staff to effectively participate in the ATIE. Limited funding leads to HEI faculty and staff shortages and heavy teaching, administrative, and research workloads. Furthermore, HEIs require capacity strengthening in research and development, innovation patenting, incubation of ideas and enterprises, commercialization of innovations, fundraising, soft skills, and dissemination.

Infrastructure and equipment

HEIs have deficiencies in infrastructure, including obsolete equipment and technologies, lack of modern laboratories, and specialized equipment to conduct modern research that addresses current issues in the

ATIE. Where modern laboratories and equipment exist, the infrastructure is not big enough to accommodate the growing number of students, affecting the quality of research and research outputs.

Institutional initiatives and support

Institutional frameworks and linkages between HEIs and other ATIE actors are weak, affecting partnerships and collaborations. In addition, research priorities are misaligned between HEIs and other ATIE actors, leading to a mismatch in funding. Therefore, for better engagement and commitment, partnerships and collaborations should be supported by clear and robust documentation and guided by clear policies that define the type and level of engagement between HEIs and other actors within the ATIE.

Financial resources

The full participation of the HEIs in the ATIE is constrained by inadequate funding to support infrastructure and equipment, human resource training, and financing of innovative solutions from ideation, conceptualization, prototyping, piloting, and scaling up.

RQ5: WHAT ARE ECOSYSTEM ACTORS' PERCEPTIONS OF HEIs' PROVISION OF KEY RESOURCES NEEDED FOR STRENGTHENING THE ATIE?

Key resources provided by HEIs to strengthen the ATIE include human capital for research and training, agricultural land and research infrastructure, and knowledge and information.

Human capital for research and training

HEIs provide human capital for training, research, and innovation that are relevant to the ATIE. HEIs train students, produce research-based innovations, and provide technical assistance to support AgriTech development as well as providing community outreach to farmers.

Agricultural land and research infrastructure

HEIs provide agricultural land and research infrastructure, including learning facilities, laboratories, machinery, and equipment that support research and innovation. However, results from the study show

that the infrastructure, such as laboratories, can only provide minimal support services to non-HEI actors since they are relatively few and lack state-of-the-art technology to facilitate quality innovation.

Knowledge and information resources

HEIs are a valuable source of knowledge and information on incubation processes and experimental field testing (e.g. breeding of new crop and livestock varieties and processing of agricultural produce) that are utilized by actors in the ATIE. The information is accessed by actors in the ATIE in the form of books, e-resources, publications and manuals, laboratory protocols, among others. However, findings show that some actors with low literacy levels, especially farmers, have limited access to this information.

RQ6a: GOVERNMENT POLICY

HOW DOES THE POLICY/REGULATORY ENVIRONMENT SHAPE THE INCENTIVES AND DISINCENTIVES FOR HEI ENGAGEMENT IN THE ATIE?

Government policies, laws, and regulations as incentives

This question concerns the policy/regulatory environment (legal formation, tax implications of investment, intellectual property protection, level of policy responsiveness to emerging new fields and needs) and how it incentivizes and disincentivizes HEI engagement in the ATIE. Government policies, laws, regulations, and agencies that support the participation of HEIs in the ATIE include the following:

- Science, Technology and Innovation Act of 2013
- Universities Act of 2012
- Commission for University Education (CUE)
- National Commission For Science, Technology & Innovation (NACOSTI)
- Kenya National Innovation Agency (KeNIA)
- National Research Fund
- National Agricultural Research System Policy

For example, the CUE, NACOSTI, and KeNIA support HEIs in the development of curricula that enable training students in different areas that are key to AgriTech innovation.

Government policies and taxes as disincentives

Study findings show that some government policies and laws constrain the effective engagement of HEIs in research and AgriTech innovation. Such policies and laws include the National Tax Policy, the Finance Act (amended every financial year), and the National Trade Policy. These policies and laws create costs in form of fees and taxes, lengthy procedures for licensing and standardization of innovations, and competition for startups by promoting the importation of raw materials and cheap low-quality products.

In addition, the Buy Kenya, Build Kenya strategy of 2017 aims to increase competitiveness of locally produced products, though respondents felt the strategy was not effectively enabling local products to compete with cheap imports.

RQ6b: HIGHER EDUCATION POLICY

HOW DO HEIS' POLICIES INFLUENCE THE INCENTIVES AND DISINCENTIVES FOR HEI ENGAGEMENT IN THE ATIE ?

RQ6b concerns how HEI policies influence HEI engagement in the ATIE (e.g., faculty and students' proclivity to engage and business interest in collaborating with HEI stakeholders to meet innovation needs).

Internal HEI policy incentives

HEIs have internal policies that guide research and innovation that are informed by the national government policies, laws, and regulation, especially the Universities Act of 2012. For example, the Human Resource Management Policies and Procedures motivates faculty and staff to undertake research by pegging promotions on the number of scholarly publications, research grants, new innovations, and patents produced. In addition, this policy requires faculty and staff to regularly engage in research and innovation in addition to teaching, carrying out administrative duties, and community outreach activities. However, some HEI faculty reported that heavy teaching and administrative workloads constrain faculty time for research and innovation.

Internal HEI policy disincentives

Findings show that there are some internal HEI policies that discourage faculty and staff from undertaking research and innovation. For example, the benefit-sharing arrangements in HEIs are developed in such a way that the institution that hosts the innovation gets a larger share of the proceeds from the commercialized innovation products than the innovator. However, some respondents expressed views in support of royalty sharing with their host universities since innovators receive support from the host institutions. In addition, findings show that the commercialization of innovations remains largely untapped due to the absence of clear policies and university institutions dedicated to supporting commercialization of HEI innovations.

RQ 7: HOW DO MARKET-RELATED FACTORS IN KENYA SHAPE OPPORTUNITIES FOR HEI ENGAGEMENT IN THE ATIE?

Kenya has a relatively vibrant and dynamic market with many start-ups, entrepreneurs, and investors involved in developing and adopting new AgriTech solutions. There is a high demand and consumer preference for innovative products and services produced by HEIs. However, tax and trade policies disadvantage local startups that need to compete with established large companies and cheap imports.

RQ 8: HOW DO CONTEXT-SPECIFIC NORMS, PERCEPTIONS, AND VALUES AFFECT HEI ACTORS' PROCLIVITY TO ENGAGE IN THE ATIE?

Public trust in HEIs' ability to innovate encourages HEI actors to participate in the ATIE. However, several norms, perceptions and values constrain HEI actor engagement in the ATIE, including negative attitudes towards new technologies among some end-users, such as farmers; negative attitudes towards employment in agriculture among HEI graduates; perceptions of HEI faculty and staff as inaccessible; and gender and age norms that limit the impact of HEI support to women and youth.

Most trust HEIs' ability to innovate, though some claim farmers have negative attitudes toward new technologies

HEIs are held in high regard by stakeholders when it comes to providing AgriTech solutions because of their ability to produce quality research and innovation. The trust and respect accorded by non-HEI actors to HEIs motivates them to engage and create innovative solutions for the agricultural sector.

Despite the widespread trust in HEI capacity to innovate, there is still low uptake of some technologies among some farmers. Some claim this is due to a negative attitude among some end-users towards new technologies and innovations in favor of traditional ones. For example, despite advantages such as high yields, pest and drought resistance, and high nutritional value from new crop varieties produced by HEIs, farmers prefer varieties that they have replanted over the years. The reluctance of farmers to adopt new technologies and products could be due to the fear of risks associated with new innovations, tastes and preferences acquired over time, or the insufficient engagement of HEI actors with farmers to ensure technologies meet farmers needs and capacities.

Negative attitudes towards employment in agriculture

Findings show that the agricultural sector does not offer many employment opportunities that are attractive to graduates. This discourages students from pursuing agriculture-related academic programs. Graduates of agriculture-related programs prefer white collar jobs outside of the agricultural sector. The negative attitude towards employment in agriculture deprives the ATIE of valuable expertise and skills.

HEI faculty and staff seen as inaccessible

There is a perception by some ATIE stakeholders, especially farmers, that HEI faculty and staff are sometimes inaccessible due to the scholarly language they use when communicating new crop varieties or technologies. Such perceptions and stereotypes limit transfer of knowledge and engagement between HEIs and other actors within the ATIE.

Gender and age norms limit effectiveness of HEI support to women and youth

Some traditional beliefs are biased against women and the youth, preventing them from making decisions regarding the control of agricultural land, means of production, and proceeds, without consulting their male counterparts or parents and caregivers. These biases reduce opportunities for HEIs to meaningfully engage directly with women and the youth.

Mistrust - fear of intellectual property theft

Several HEI actors also indicated that they feared registering innovations due to concern that public officials might steal their innovations and sell them to a third party. This represents a considerable barrier to protection and commercialization of innovations.

RECOMMENDATIONS

RECOMMENDATIONS FOR THE GOVERNMENT OF KENYA

1. **Review and reform government policies, laws and regulations on trade and taxation:** The government should revise policies, laws and regulations on taxation and trade to include measures that protect AgriTech start-ups from competition arising from imports, streamline procedures for licensing and standardization of innovations, and reduce associated costs.

2. **Revise licensing and standardization procedures and fees:** The government should revise the procedures and fees for licensing startups and standardization of innovations to avoid lengthy processes and associated costs.

3. **Increase funding to public HEIs for AgriTech research and innovation infrastructure development:** Increase funding to public HEIs to support upgrading and setting up new infrastructure such as modern laboratories and specialized equipment to facilitate cutting-edge research and innovation within the ATIE.

4. **Fulfill the funding requirements of the Science, Technology and Innovation Act of 2013:** As of 2023, the government was only investing 0.8% of GDP in HEI research - well short of the 2% outlined in this policy (UNESCO, 2023) Government funding for HEI research could go a long way to spur additional research to support the ATIE, especially in sectors research participants labeled as underdeveloped, such as water management, agricultural processing, and livestock. Consider initiatives that incentivize private sector actors to co-fund research with the government, such as matching grant opportunities.

5. **Develop and implement a national intellectual property policy, streamline intellectual property application procedures, and institute e-government intellectual property applications to reduce opportunities for corruption:** UNESCO (2023) notes that Kenya lacks a national intellectual property policy and the

current legal instruments for protecting intellectual property are not "harmonized." Also, research participants indicated that the process for registering intellectual property, such as patents, is lengthy and costly, and five HEI respondents indicated fear of intellectual property theft during the process from public officials charged with processing applications. Creating a harmonized intellectual property policy, streamlining application procedures, and instituting an e-government application process can help address these barriers to intellectual property registration.

6. **Operationalise policies, laws and regulations, and to prevent gender and age discrimination:** The government should operationalise, review or reform existing laws, policies and regulations to curb any form of discrimination that prevents women and the youth from meaningful engagement with HEIs and their full participation in the ATIE.

RECOMMENDATIONS TO HEIS

7. **Create revenue mobilization strategies for AgriTech research and innovations:** HEIs should create strategies including grant writing, partnerships and collaborations, and other income generating activities aimed at mobilizing funds to support AgriTech research and innovation.

8. **Increase promotion and dissemination of new AgriTech solutions:** HEIs should increase their promotion and dissemination efforts of technologies and innovations to reduce negative attitudes towards new technologies and ensure increased adoption by end-users. Communication messages and channels should be tailored and segmented to reduce communication barriers and reach different audiences within the ATIE.

9. **Undertake research on barriers to uptake and adoption of new AgriTech innovations:** HEIs, working together with the government and other actors in the ATIE, should carry out social norms and behavior change communication research to understand barriers and facilitators to farmer uptake of Agritech solutions and effective communication channels and messages to shift farmer behavior.

10. **Streamline and strengthen institutional frameworks and policies for partnerships and collaborations with other ATIE stakeholders:** Refine and strengthen institutional frameworks and policies to reduce institutional bureaucracies in order to promote partnerships and collaborations in areas of fundraising, research, innovation, infrastructural and skills development with other actors within the ATIE.

11. **Promote research commercialization:** Review and design policies and strategies to set up or strengthen specialized units dedicated to research commercialization, and tailor HEI policies to effectively incentivize faculty and staff to engage in research and innovation. Consider the World Intellectual Property Organization's guide on how to identify the appropriate mix of incentives within a given context: Incentives in Technology Transfer A guide to encourage, recognize and reward researchers and professionals (WIPO, 2024).

12. **Build capacity of HEI faculty and staff in research and innovation processes:** HEIs should carry out capacity assessments to identify skill gaps in research and development, innovation patenting, incubation of ideas and enterprises, commercialization of innovations, fundraising, soft skills, and dissemination and offer necessary capacity strengthening trainings.

13. **Develop faculty promotion policies that reward faculty innovation and research impact** and uptake to incentivize faculty alignment of research and innovations with the needs of end-users, such as farmers and private sector actors.

14. **Merge agricultural academic programs with other in-demand courses:**[2] Given the low interest in youth engagement in agricultural courses, merging agricultural courses with other in-demand courses can help attract more young people to the sector.

[2] This idea emerged from participants who attended the HEIGHTS IE research findings validation session in Indonesia, but may be a transferrable idea to the Kenyan context.

INTRODUCTION

STUDY PURPOSE AND AUDIENCE

The goal of this study is to inform USAID's "education strategic planning, activity design, and professional development" in the areas of higher education institutions' engagement in the AgriTech Innovation Ecosystem (ATIE) in support of the USAID Higher Education Learning Agenda (USAID, 2020). To achieve this goal, the study produced evidence-informed strategies to strengthen higher education institution (HEI) engagement in the ATIE within Kenya. Specifically, this study analyzes how HEIs, across their many forms, can positively influence the ATIE through a variety of roles, while taking into account limiting factors like resources, relationships, and social norms. The research is part of a multicountry comparative study involving Kenya, Indonesia and the Philippines. The audience for the output of this study includes the following stakeholders: USAID Washington's Center for Education, USAID/Kenya Mission, as well as other USAID Missions worldwide engaged in Higher Education activities, multilateral organizations funding higher education activities in low- and middle- income countries (LMICs), and the Government of the Republic of Kenya, especially the Ministry of Education (MoE). Ultimately, the classification of HEIs involved in this study included only universities.

CONTEXT AND PROJECT BACKGROUND

KENYA'S NATIONAL POLICY CONTEXT AND DEVELOPMENT GOALS

Kenya's 2030 Vision emphasizes the role of science, technology and innovation (STI) as one of the key foundations of achieving the goal of transforming the country into a newly industrializing, globally competitive, and prosperous upper middle income country with a high quality of life for all citizens by 2030 (Government of the Republic of Kenya, 2007). In 2012, the then Ministry of Higher Education, Science and Technology (now Ministry of Education), formulated a policy framework for STI, recognizing the significance of STI aiding Kenya's social and economic transformation. In 2024, the Global Innovation Index (GII) ranked Kenya 6th in Sub-Saharan Africa and 95th globally (WIPO, 2024). Kenya's highest rankings in the GII include it ranking 87th in innovation outputs and 75th in knowledge and technology outputs (WIPO, 2024). Higher education institutions (HEIs) including universities, Technical and Vocational Education Training (TVET) institutions and research institutes play a key role in supporting STI in Kenya as sources of innovation ideas and activities (Government of the Republic of Kenya, 2021).

HIGHER EDUCATION CONTEXT IN KENYA

The Government of Kenya recognizes the education sector as vital in the development of the country's economy. It envisions an education, training, research, and innovation system that is globally competitive and supports sustainable development (Government of Kenya, 2007). HEIs are vital to national economic and social growth because they foster innovations based on research through partnerships, networks, and collaborations (Ochako and Katua, 2023).

In Kenya, the number of public universities has risen from 57 in 2012 to 81 in 2023 (UNESCO, 2023). Since HEIs in Kenya continue to expand, these statistics are dynamic. As the number of HEIs grows, there is a need to consider their roles and functions in the country's innovation ecosystem. Due to the limited finances dedicated to research and innovation, the impact of HEIs on the innovation ecosystem space has not been adequately realized (Ochako and Katua, 2023). Teaching activities have been given precedence over research and innovation (UK Department for International Development, 2019). Further, there is poor coordination between the various actors in the innovation ecosystem (Fingo, 2020). Older universities have partnered with industry and are contributing to the innovation ecosystem, however, their engagement is not optimal (Ochako and Katua, 2023). There is also a lack of an enabling policy to encourage the participation of HEIs in the innovation ecosystem space (Ochako and Katua, 2023). Despite the noted challenges, the entrepreneurial spirit that fuels innovation in Kenya is seen as just starting (UNDP, 2022).

Inspired by the progress and successes in the Kenyan innovation landscape, some Kenyan universities developed programs aimed at preparing students in innovation and entrepreneurship. Examples of such programs include: the Integrated and Circular Technologies for Sustainable City region FOOD Systems in Africa (INCiTiS FOOD) program that has established Living Labs at Kenyatta and Egerton Universities to incubate innovations on sustainable food production and the Strathmore Agri-Food and Innovation Center (SAFIC) and the iLabAfrica program at Strathmore University that are dedicated to fostering sustainable agricultural growth and innovation, research, and entrepreneurship. In addition, some top innovations that HEIs are involved in include Ecodudu, an innovation that uses agricultural waste to produce fertilizers, and Taimba, an AgriTech innovation that connects smallholder farmers directly to urban retailers, improving access to fresh produce (With et al., 2022). Both of these innovations were incubated at Kenyatta University.

AGRITECH INNOVATION ECOSYSTEM IN KENYA

Agritech, broadly defined as the use of technology to improve agriculture and food production, can help farmers increase their yields, reduce their costs, and access new markets (UNCTAD, 2017). While agriculture contributes about 20% of the Gross Domestic Product (GDP) of Kenya (Central Bank of Kenya (CBK), 2023), over 80% of the country is arid and semi-arid land (Asawo & Wanyonyi, 2021) and therefore using technology and innovations to improve agriculture and food production is vital. Agritech can also help consumers access fresh, nutritious, and affordable food (Ochako and Katua, 2023). In the agricultural sector, the focus of digital technologies has been in enabling better access to markets through e-commerce, digital procurement solutions and mobile money services. This has expanded how digital solutions can address barriers for farmers with disabilities and improve how agribusinesses and farmers interact (Aranda-Jan, 2020). Among the services are digital advisory, agri-digital financial services, digital e-business, and smart farming (use of sensors, drones, satellites and other farm assets to generate and transmit data about a specific crop, animal or practice to support agricultural activities).

Despite the paucity of the literature on the subject, the evolution of the Kenyan innovation ecosystem may be traced to around two decades ago (Ndemo, 2016; UNDP, 2022). The formal Kenyan innovation ecosystem was launched approximately 15 years ago with the first attempt to map out the status of the country's innovation sector (Fingo, 2020). This formal endeavor was triggered by events like the drop in the prices of phones and the laying of the undersea cable for Internet by African Online in 2005/2006 and in 2007. Before this, there was no regulatory and policy environment in the area of innovations.

The Agritech innovation ecosystem still faces several challenges. Key challenges to the Kenyan innovation system appear on two levels: policy and operations (Kieti et al., 2022). Among the key challenges is poor coordination of the supportive policies resulting in weak linkages between HEIs and industry (OACPS, 2023). In addition, the education system has not encouraged the establishment of more industry-friendly vocational programs to build innovation-ready human capital across the pipeline from ideation through to a sustainable scale (Ng'ang'a et al., 2019). Although the Agritech innovation ecosystem has shown vibrancy, with catalytic funds such as Uwezo dedicated to women, youth, and people with disabilities, it still demonstrates some levels of marginalization (UNDP, 2022; Ongera, 2016). A range of gaps and barriers persist across Kenya's research and innovation ecosystem when it comes to growth of innovation ecosystems.

There is a need to understand the involvement of HEIs in the innovation ecosystem of Kenya. This will enable the formulation of policies and strategies to enable HEIs in LMICs to engage more effectively in and strengthen national and community innovation ecosystems. Our study focused on the relationship among actors, resources, and the enabling environment for accelerated growth of the innovation ecosystem.

RESEARCH QUESTIONS

To achieve the objectives laid out in the study purpose, the research study addresses the following overarching question: What lessons can be derived from analyzing the involvement of HEIs in Kenya in the ATIE that could inform policies and strategies to enable the HEIs to engage more effectively in and strengthen national and/or subnational innovation ecosystems?

To answer this question, the research team derived from the Hoffecker (2019) and 5Rs Framework a series of research questions along five major themes: (1) Outcomes/Results, (2) Actors/Roles, (3) Relationships, (4) Resources, and (5) Enabling Environment/Rules. The research team used a mixed-methods approach to answer the following questions:

- **RQ1:** What are ecosystem actors' perceptions of the level of development[3], functionality, and purpose of the innovation ecosystems under study?[4]
- **RQ2:** What roles are higher education institutions in this study currently playing in the innovation ecosystems of focus?[5]
- **RQ3:** What is the level of coordination and partnership between key actors in the HEIs under study and the actors engaged in the innovation ecosystems under study?
- **RQ4:** What resources do the stakeholders at the higher education institutions included in the study need to be able to engage effectively in the innovation ecosystems of focus?[6]

[3] According to Hoffecker (informal conversation, 2022) ecosystem actors can generally give a broad sense of the level of development, but are usually surprised about the actual number of actors in the system. Hoffecker suggests looking at the level of development according to broad categories, such as: (1) large, vibrant, and well-developed; (2) medium, growing, in the process of diversifying; (3) nascent and underdeveloped.

[4] We will use a participatory approach to define "functionality" of the innovation ecosystem. This approach encourages ecosystem actors to define their goals for the innovation ecosystem and compare those goals with the current state of the innovation ecosystem and the process features needed to reach their goals.

[5] The roles outlined in detail by Hoffecker (2019) include innovate ("identify..and put to use new ways of doing things"), celebrate ("promot[e]... local innovators"), train, advocate, convene ("facilitat[e] mutually beneficial interactions" between key actors), connect (strengthen networks, relationships, and value chain development), fund, and share knowledge (Hoffecker 2019, 7).

[6] Hoffecker (2019) identifies the following resources: (1) natural resources; (2) human capital; (3) infrastructure; (4) social capital; and (5) financial resources as necessary for innovation ecosystem development (8). In addition to the resources Hoffecker (2019) identifies, we would suggest adding resources to help research bridge the gap between

- **RQ5:** What are ecosystem actors' perceptions of higher education institutions' provision of key resources needed for strengthening the innovation ecosystems of focus?
- **RQ6a:** How does the policy/regulatory environment (legal formation, tax implications of investment, intellectual property protection, level of policy responsiveness to emerging new fields and needs) shape the incentives and disincentives for HEI engagement in innovation ecosystems?[7]
- **RQ6b:** How do higher education institutions' policies influence the incentives and disincentives for HEI engagement in innovation ecosystems (e.g., faculty and students' proclivity to engage and business interest in collaborating with HEI stakeholders to meet innovation needs)?
- **RQ7:** How do market-related factors in each country shape opportunities for HEI engagement in innovation ecosystems?
- **RQ8:** How do context-specific norms, perceptions, and values affect HEI actors' proclivity to engage in innovation ecosystems?

invention and commercialization (see Jackson, 2011). We will also identify relevant resources inductively through key informant interviews.

[7] Hoffecker (2019) indicates "[t]he types of laws, regulations, and policies that exist in a location, as well as the manner and extent to which they are enforced, create the incentives—or disincentives —for innovation. From laws protecting intellectual property to regulations influencing the ability to start a new company to tax and certification policies, the legal, regulatory, and policy context directly affects the functioning and performance of local innovation ecosystems" (9).

METHODOLOGY OVERVIEW

The study used qualitative methods to collect the data through semi-structured interviews with key stakeholders in the ATIE. The stakeholders included representatives from Universities (faculty, staff, and students), the private sector, civil society, national and county government ministries, government agencies, entrepreneurs, and economic development agencies. Data was collected using key informant interview (KII) guides (see **Annex 2** & **Annex 3**).

Kenya has 81 universities, of which 54 are involved in research and training in agriculture. Out of these, 16 universities have innovation and incubation hubs. A total of seven universities were purposefully sampled for inclusion in the study. Five of the selected universities represent key agro-ecological zones in Kenya and have well-established innovation and incubation hubs. Two more universities representing high and low agricultural productivity zones were also selected, though they do not have innovation and incubation centers. Their inclusion was to further understand barriers to establishing innovation and incubation centers.

Representatives of government, private sector, civil society, and HEI faculty, staff, and students were selected purposefully. Government representatives were drawn from medium level national and county government ministry officials dealing with agriculture and livestock and interacting with the sampled HEIs. Private sector actors were selected through snowballing of mainly entrepreneurs and farmers interacting with the sampled HEIs. Civil society actors were also listed through snowballing of non-governmental and community based organizations.

DATA COLLECTION

Data collection took place between February to May 2023. Out of the seven universities sampled, data were collected from six. A total of 42 key informant interviews were conducted, of which 16 were with HEI faculty and staff, two students, eight private sector, eight civil society, eight government officials (one national ministry official, one county government ministry official, and six officials from government agencies) see **Table 1**. As much as an equal number was targeted for each of the groups, only two student innovators and two government ministry officials, respectively, were available for the interviews. We conducted six FGDs with participants that included HEI actors (faculty, staff, students), farmers, entrepreneurs, private sector experts, civil society, and government representatives. All semi-structured interviews were conducted by two people: an interviewer and a notetaker. The interviews were conducted by the principal investigator (PI) and co-principal investigator (Co-PI), who are senior researchers. The PI and Co-PI were each assisted by a research associate who took notes of the

interview. The researchers used a semi-structured interview protocol that was designed based on the Hoffecker (2019) conceptual framework. Interviews were conducted either face to face or virtually and lasted between 21 to 110 minutes.

Table 1. Final Data Collection

Methodology	Respondent Category	Number of Participants
Key Informant Interviews (KIIs)	HEIs[8]	18
	University faculty	12
	University staff	4
	Students	2
	Private Sector	8
	Entrepreneurs	5
	Farmers	1
	Private sector experts	2
	Civil Society[9]	8
	Government	8
	Gender	
	Male	26
	Female	16
	Total	**42**
Focus Group Discussions (FGDs)	Stakeholders by Group	51
	Farmers	4
	Entrepreneurs	10
	Industry	4
	Government	11
	Universities (faculty, staff, and students)	18
	Civil Society Actors (e.g., NGOs and CBOs)	4
	Gender	
	Male	36
	Female	15
	Total	**51**

[8] Five public and one private HEIs were included in this study. Out of these, only four have incubation centers.

[9] This group is composed mainly of non-governmental organizations and civil society organizations.

DATA ANALYSIS

The interviews were transcribed verbatim, checked for accuracy, and entered into the Dedoose software for thematic coding and analysis. The tool enabled collaborative coding of texts and exploration of each code. This helped in the examination of relationships. The tool further helped the research team to create descriptions for each code and generate the key themes. This way, the tool facilitated interpreting, synthesizing, and identifying patterns to draw conclusions backed by strong and supporting quotes.

Data coding and analysis were led by the PI with support from the Co-PI and a small team of research associates. The PI for the cross-country HEIGHTS study assisted the data analysis process, including providing feedback on the consistent generation and application of codes during the analysis. As part of the coding process, the coding team identified excerpts from the transcripts relevant to each research question and coded them using the codebook generated a priori. On a bi-weekly basis, the study team met to review progress and update the codebook with any new codes. This coding process was supported by the PI based at the University of Notre Dame. Finally, the study team identified emerging themes and patterns in the data.

RESEARCH ETHICS

Informed consent was obtained from all study participants prior to participating in the interviews, and participants had a right to refuse to participate in the study, withdraw from the study at any time, or refuse to answer any question without a penalty (see details of the consent in **Annex 1**). We kept the details of the participants and the data confidential throughout the research process. Ethical approval was obtained at the University of Notre Dame and the University of Nairobi. A research permit to start field data collection was obtained from the National Commission for Science, Technology & Innovation (NACOSTI).

LIMITATIONS

Limited prior research studies on HEI engagement in the ATIE

There is a paucity of prior research studies on the engagement of HEIs in the ATIE, and this could have limited our deeper analysis of this engagement and issues that HEIs face as they participate in the activities related to the ATIE. Initially, the study aimed to focus on HEI's engagement in the bee farming

innovation ecosystem, but due to the limited literature, the scope of the study was expanded to include the ATIE. However, issues of limited literature were still evident.

Lack of diversity in sampled HEIs

The representation of HEIs for this study was limited to only universities. Therefore, the results of this study can not provide a complete picture due to the absence of views and information from other HEI types like Technical and Vocational Education and Training (TVET) institutions involved in the ATIE.

Lack of responsiveness

Some of the sampled respondents were not available for interviews. For example, out of the seven sampled universities, data was collected from only six. Of the six universities included, five were public, and one was private. Also, five were from the highlands, and one was from the coastal area. While the sample draws from the entire country and is illustrative of issues relevant to HEIs, the small sample size means that these findings cannot be generalized to the population of HEIs in the country. Also, the research team was only able to secure interviews with two students and one county government official, and thus, insights from these groups may not fully reflect the views of these groups.

Imbalanced Gender Representation in Respondent Sample

Finally, while we endeavored to have an equal number of male and female respondents, there were more male respondents than females. The team interviewed 26 females engaged in the ATIE, compared to 62 male participants. The larger sample of male respondents may mean that this group's views are more heavily represented.

FINDINGS

OUTCOMES/RESULTS

RQ1: WHAT ARE ECOSYSTEM ACTORS' PERCEPTIONS OF THE PURPOSE, FUNCTIONALITY, AND LEVEL OF DEVELOPMENT OF THE AGRITECH INNOVATION ECOSYSTEM (ATIE) IN KENYA?

This research question seeks to elucidate respondents' views on the status of the AgriTech Innovation Ecosystem (ATIEs), why it exists (its purpose), how it functions, and its operational efficiency in achieving its intended goal. The purpose of the ATIE was mentioned to include improving agricultural productivity and food security, as well as promoting agribusiness. The ATIE consists of various actors, including knowledge generators such as HEIs and research organizations; knowledge translators including extension workers; Civil Society Organizations (CSOs); knowledge users such as farmers and other supply chain actors, policymakers, and conservation organizations; funding agencies such as National Government, National Research Fund, World Bank, United States Agency for International Development (USAID), and World Food Programme. Other actors include innovation and incubation centers, quality control and certification agencies, marketing agencies, processors, and aggregators. These actors play various roles and interact at varying levels (international, regional, and national) within the ATIE (See RQ 2 findings for details). Various views were expressed regarding the level of development of the ATIE, with some respondents categorizing it as medium and others as underdeveloped. Among HEIs, this study involved solely universities.

Purpose of the ATIE

Representatives of HEI faculty, staff and students, government, private sector, and civil society expressed several views on the purpose of the ATIE in Kenya, but mainly converging on the following two: (1) improving agricultural productivity, food security, and resilience, and (2) promoting agribusiness.

Improving agricultural productivity, food security, and resilience

Representatives of HEIs, government, and civil society mentioned that the purpose of the ATIE in Kenya is to improve productivity in agriculture and food security through various innovations led by HEIs. Representatives of HEI faculty, the government, the private sector, and civil society noted that there exists a wide variety of innovations within HEIs that address challenges in soil, crops, and animals, as well as energy, mechanization, and equipment, all of which contribute to enhancing agricultural productivity that also improves food security. The ATIE facilitates the development of new crop varieties that are high yielding, resistant to pests and diseases, early maturing, nutritious, and hence resilient to climate change and variability, as a major contribution to improved agricultural productivity and food security, as illustrated in the quote below.

> "When it comes to food security, our researchers have come up with new crops, some of which are resistant to diseases, others to pests, [others are] high yielding and early maturing. This has really helped in the food basket, especially when it comes to climate-smart crops. We have given some of these crops to farmers, although at very low levels."
>
> – HEI Faculty Representative

Further, representatives of the government, civil society, and HEI faculty mentioned that innovations in machinery and other equipment increase efficiency in production and productivity by reducing drudgery and thereby ensuring the future growth of the sector. They noted that some of these innovations in equipment specifically target small-scale farmers who are the main contributors to agricultural production in Kenya. This is illustrated by the quote below from a representative of a government-affiliated research institution.

> "They [HEIs] are bringing solutions that [simplify existing processes.]. For example, mechanization… reduces [labor] and … makes agricultural production efficient. At the same time, they are working with the industry on prototypes or equipment to [supply] to farmers."
>
> – Research Institution Representative

Promoting agribusiness

Representatives from the government, civil society, and HEI faculty mentioned that the ATIE promotes agribusiness[10] through the processing and marketing of agricultural products. Representatives of the civil society and the private sector agreed that in addition to agricultural processing and marketing, ATIE addresses the gaps in agribusiness, mainly through knowledge generation, translation, and transfer of information by discussing, showcasing, and disseminating innovations and information to support agribusiness and promote growth in the broader agricultural sector, as captured in the quote below.

"The most important point, I would say, is imparting knowledge. In the past, we had four major problems that the Agribusiness sector faced [that include] [lack of] market, knowledge [gaps], [effects of] climate change, and [limited] resources. The universities are able to address the knowledge gap."

– Private Sector Representative

Functionality of the ATIE

The representatives from HEIs and the government noted that actors within the ATIE interact at varying levels, namely international, regional, and national. Representatives from the private sector mentioned that the innovation space requires several actors and their close collaboration for innovations to be market-ready.

"Innovation is an area that requires collaboration between the players because sometimes scientists may discover or develop some technologies that may require fine-tuning. For example, scientists in Jomo Kenyatta University may need to work with farmers so that they make technology that is more appropriate, more focused on the farmer and more marketable so that it can have an impact."

– Private Sector Representative

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[10] Agribusiness involves the production, processing, and distribution of farm-based goods.

In addition, representatives from HEIs, the government, the private sector, and civil society stated that interactions of the ATIE actors range from collaborative or joint activities such as conferences, workshops, research projects, partnerships, curriculum delivery, and funding research. Further, representatives noted that the actors interact to achieve common or individual objectives that include financial support, research, knowledge and skills transfer, agricultural processing, and marketing of agricultural products. Representatives of HEI faculty mentioned that by working together, the actors within the ecosystem can function efficiently by sharing expertise and resources, such as specialized laboratory equipment and/or analytical skills.

> "Working with other people opens up the mind to other things. We might not have all the expertise required, but we can get it by collaborating. For example, we collaborate with the Kenya Marine and Fisheries Institute, which has a very well-funded laboratory. That collaboration allows our students to go work with the specialized equipment."
>
> – HEI Faculty Representative

However, there are important barriers to these actors' efficient and effective collaboration, which are detailed under research question 3. These include bureaucratic barriers to collaboration between HEIs, inadequate policies for establishing HEI-private sector collaborations, and poorly staffed innovation offices to link HEI-produced innovations to the private sector for commercialization (this last point is detailed under RQ6b).

Level of Development of the ATIE

Representatives of HEIs, the government, civil society, and the private sector had varying views on the level of development of the ATIE. While most representatives from HEIs, the government, and civil society mentioned that the level of development of the ATIE is at a medium stage, some representatives from the private sector, the government, the civil society, and HEI faculty considered the ecosystem to be underdeveloped. Respondents largely used the amount of research and innovation and the level of dissemination, uptake, and commercialization as key indicators to explain their assessment of the level of development.

Notably, representatives from the HEI faculty, the government, and the private sector noted that the development of the ATIE varies across sectors relevant to the ATIE. For example, while sectors like the

seed industry, pest control, and Information Technology (IT) are relatively well developed, the water management, agricultural processing, and livestock sectors are lagging, as illustrated by the quote below.

"[...] we are at a medium level relative to others; we are better in some sectors. If you look at, for example, the seed industry, pest control products, and IT solutions for agriculture [...]. However, in some areas, for example, water challenges and agricultural processing, we need more innovation there. This is [due to] the low industrial base of our country. [...] The intensity of research in Kenya is quite high; we not only have local but many international institutions [...] doing research in Kenya. Together, [...] they have contributed to this good progress. We also have a thriving private sector [that] is oriented to innovation and an internationally connected research innovation system. I would say we are at medium level and headed to high."

– HEI Faculty Representative

As shown in the quote above, representatives that viewed the ATIE to be at a medium level of development attributed this to several factors, including the availability of robust research and innovation opportunities, the technical capacity of the HEI faculty, a thriving private sector, availability of funding and investment, and the presence of diverse actors within the ecosystem. This view is shared by some civil society representatives, as captured in the quote below.

"In my opinion, the stage of development is medium and growing, heading to quite developed. I say this because I have seen innovations across different parts of the value chain, right from production at the farm all the way [...] [to] how the goods get to the market. I have also seen quite a number of youths participating across all those different levels of the value chain. In the past, especially at the very high end of technological development, [...] [the value chain] was heavily dominated by foreign-based entrepreneurs. But now we are seeing a lot of local innovators building several software solutions. So I would say that ATIE development is at medium tending to high."

– Civil Society Representative

On the other hand, some representatives from HEIs, the government, civil society, and the private sector highlighted several challenges that undermine the progress of the ATIE, including: (1) low-levels of

dissemination/awareness, adoption, and commercialization of agritech research and innovations; (2) low-interest from government leadership and bureaucracy; (3) weak protection of intellectual property rights; (4) low-promotion of technologies that are informed by traditional knowledge; (5) low-levels of innovation culture among actors especially HEI faculty, and (6) low-level of industrial development. Some of these challenges are illustrated by the quotes below.

> "I would say we [ATIE] are somewhere in the middle. There are many innovations taking place at the higher institutions of learning, although dissemination of these innovations is still lacking. If we disseminate this information to the smallholder farmers, that will really help in pushing these Agritech innovations. When a university promotes a technology, farmers will actually adopt it faster than most of the other institutions. So there is still more to be done, especially in developing technologies that are tailor made for the smallholder farms."
>
> – Civil Society Representative

Government leadership and bureaucracy also contribute to the level of development as alluded to by a private sector representative:

> "Let me give the example of mechanization and irrigation because [they have] a lot of influence on the ecosystem. I would rate it [ATIE] as middle. The situation [development of ATIE] is influenced by leadership [government]. For example, right now there is a lot of drought, yet we have rivers and dams that can be operated to irrigate our farms. But if you observe, there is nothing [being done by the government to take advantage of the opportunities of the available resources like rivers and dams to promote irrigation]."
>
> – Private Sector Representative

Some representatives from the private sector, the government, and HEI faculty intimated that it is the government's responsibility to provide resources for co-designing and co-developing technologies with users, especially local communities to promote their adoption. However, a representative of the civil society mentioned that while the role of government is clear, most local communities lack access to new technologies and products, as illustrated by the quote below.

"Generally, innovation and technology [are] below average because the technologies talked about, especially by the leadership in the county, are absent where the farmers are. So, I would say that, for example, in Kilifi County, we are below average. As far as we see at the county level, where we live and work on the farms, *hakuna kitu kinaendelea* (nothing is going on)."

– Civil Society Representative

ROLE OF HEIs IN AGRITECH INNOVATION ECOSYSTEM

RQ2: WHAT ROLES ARE HEIs IN THIS STUDY CURRENTLY PLAYING IN THE AGRITECH INNOVATION ECOSYSTEM?

This section presents perceptions of the roles that HEIs play in the ATIE, including skilling and developing human capital, fostering research and innovation, and translating and disseminating knowledge. The roles align with USAID's Higher Education Program Framework and are implemented by various actors such as HEI faculty, staff, researchers, students, and innovators.

Skilling and human capital development

HEIs contribute to the training and development of human capital for the ATIE workforce. This is done both within the HEIs and through outreach activities. Representatives of the government, civil society, and HEI faculty mentioned that HEIs not only train but also mentor students at different levels (i.e., diploma, undergraduate, and postgraduate) in agricultural and related academic programs.

In addition, representatives of the government and HEIs indicated that HEIs are involved in encouraging and mentoring students to come up with innovations and products that may lead to commercialization. The quote below by a representative of HEI faculty emphasizes the role HEIs play as trainers of experts in agriculture at undergraduate and postgraduate levels.

"Being an agricultural institution, we offer training programs in agriculture. For the postgraduate students, masters, and PhD, we encourage them to publish, and we mentor them to come up with innovations out of their work."

– HEI Faculty Representative

Further, representatives of HEIs, the private sector, and the civil society reported that HEIs conduct community outreach activities targeting farmers. By conducting community outreach activities, HEIs train farmers through farmer field schools, seminars, workshops, short courses, individual farmers training, HEI open days, and experiential learning. In addition, representatives of HEIs mentioned that HEIs reach out to high school students who are future farmers and leaders. They emphasized that in Kenya, agriculture is dominated by relatively aging farmers, and therefore, reaching out to high school students presents an opportunity to involve the youth in agriculture for sustainability. The quote below by an HEI representative supports this argument and illustrates the importance of outreach activities.

"We also have other ways of training whereby secondary school students from all over Kenya apply and visit our university every Tuesday and Thursday. They tour our various agricultural areas and departments, including horticulture biotechnology, mushroom farming, and livestock [farming]. We also show them demonstrations of machinery like the tractors. So we train them because they are tomorrow's farmers and leaders. In addition, we have a day set by the university as an open day for the public."

– HEI Faculty Representative

Fostering research and innovation

Representatives of government-affiliated research institutions, civil society, and HEI faculty stated that HEI faculty and students play key roles in research. Faculty and postgraduate students undertake research that leads to innovations within the ATIE. Respondents further mentioned that the older public universities are particularly well known for research in plant and livestock breeding, processing of agricultural products, development of soil and water management technologies, and development of drought and

disease-resistant breeds. Some innovations mentioned include fortified bean varieties, drought-resistant peas and beans varieties, and disease-free tissue culture bananas. In addition, representatives of HEI students highlighted innovations in agricultural processing that include processing grass seeds into flour for human consumption and minimizing post-harvest losses for fruits and vegetables using solar dryers. A representative from the civil society had this to say:

"Innovations require identification and consequently coming up with varieties that have different attributes. For example, one key aspect is drought tolerance. When I was doing my masters [...], I worked on drought physiology, and I identified varieties of chickpea[s] that could be upgraded and evaluated. I'm happy to report that these varieties are in the process of being released. Other crops I was directly involved in include groundnuts, millet, palm millet and finger millet, and sorghum. For high yields, we have released three varieties of beans. For animals, my university has come up with better animal husbandry methods that have contributed to increased productivity in the milk value chain."

– Civil Society Representative

Translation and Dissemination of Knowledge

Representatives of the government, civil society, and HEI faculty mentioned that HEI faculty and students enhance knowledge sharing by translating and communicating research findings to various stakeholders within the ATIE. Translation and communication are done through various channels such as publications, conferences, workshops, webinars, community outreach, mass media, social media, and digital platforms, among others. The representatives of the government and the civil society indicated that translation and communication are done at different levels, i.e., international level (between fellow HEIs and researchers), national level (communicating findings to the government, the private sector, between fellow HEIs and researchers), and with farmers at the farm level. The quote below by a government representative highlights the diverse mechanisms through which HEIs communicate their research findings.

"... They also attend international conferences in which they are able to disseminate information. And for promotional purposes, they involve their students in disseminating information to the farmers and other stakeholders outside."

– Government Representative

Representatives of the private sector mentioned that HEIs share knowledge through innovation weeks and other forums. The quote below by a representative of the private sector illustrates that HEIs organize events to showcase innovations.

"They usually hold days where they discuss and showcase innovations in AgriTech. For example, Eldoret University usually has an event every year where innovations are presented and showcased. I think the university holds an innovation week to showcase and disseminate information."

– Private Sector Representative

In summary, representatives of Government, Civil Society, HEIs faculty, staff and students noted that HEIs in this study are playing vital roles as educators and trainers of HEI students and farmers, researchers and innovators in Agriculture, mentors of innovators, translators and disseminators of knowledge in the ATIE. Through these roles, HEIs have directly or indirectly contributed to various AgriTech innovations, including drought-resistant and high-yielding crop varieties and modern animal husbandry methods contributing to improved agricultural production and productivity. Examples of the AgriTech innovations include improved bean varieties, banana tissue culture, and ugali flour from grass seeds.

RELATIONSHIPS

RQ 3: WHAT IS THE LEVEL OF COORDINATION AND PARTNERSHIP BETWEEN KEY ACTORS IN THE HEIs UNDER STUDY AND THE ACTORS ENGAGED IN THE AGRITECH INNOVATION ECOSYSTEM?

The purpose of this research question is to discuss the level of coordination and partnerships between the key actors within and across the HEIs under study and between HEIs and other actors within the ATIE. Representatives of HEIs, the civil society, and the government identified partnerships between HEIs and other actors in the following activities: training, mentorship, idea incubation, research, fundraising, joint outreach activities, communication of research and dissemination of innovations. The key actors discussed among the HEIs include faculty, staff, and students, while other ecosystem actors include the government and its agencies, research organizations, the private sector (such as private enterprises, industry organizations, financial institutions, farmers, and farmer groups), development partners, and the civil society organizations.

Partnerships between HEIs

Representatives of HEIs mentioned that partnerships exist between HEIs within the ATIE in several areas, including capacity strengthening of staff, faculty, and students, training, joint research collaborations, and benchmarking visits. However, institutional bureaucracies were viewed as impediments to effective coordination, collaboration, and partnership among HEIs. Representatives of HEIs stressed that bureaucracy hinders knowledge sharing and access to other resources (such as equipment and research materials) amongst HEIs. A representative from an HEI stated that:

> "There is a lot of bureaucracy when it comes to knowledge exchange, working, or collaborating with other institutions. For example, someone from another university doing research work will face challenges accessing our research equipment or material. Sometimes they give up and go."
>
> – HEI Faculty Representative

Partnerships between HEIs, the Government and its Agencies

Representatives of the government noted that the government and its agencies are key partners to HEIs since HEIs are mandated through policy to work with government ministries and agencies. Representatives of HEIs, the government, and civil society have pointed out the various agencies (listed in **Table 2**) as key HEI partners within the ATIE.

Table 2. HEI Partners and their Roles

Key HEI Partners	Partner Roles
National Commission For Science, Technology & Innovation (NACOSTI), established by the ScienTI Act	• Accredits research institutes and Conducts ethics reviews and approvals for all scientific research in Kenya • Co-ordinates, monitors, and evaluates activities relating to scientific research and technology development • Ensures coordination and cooperation between various agencies involved in science, technology, and innovation, among other functions
Commission for University Education (CUE)	• Regulates HEI academic programs and the development of curricula • Promotes quality research and innovation • Advises the cabinet secretary on policy relating to university education; • Monitors and evaluates the state of university education systems in relation to the national development goals
Kenya Agriculture and Livestock Research Organization (KALRO)	• Promotes, streamlines, coordinates, and regulates research on crops, livestock, genetic resources, and biotechnology • Promotes, streamlines, coordinates, and regulates research in crops and animal diseases • Expedites equitable access to research information, resources, and technology and promotes the application of the research findings and technology in the field of agriculture
Kenya Industrial Research and Development Institute (KIRDI)	• Collaborates with institutions of higher learning, professional and industrial associations, government agencies, and industrial research institutions to advance technology, innovation, and development

Key HEI Partners	Partner Roles
	• Collaborates with other organizations and institutions of higher learning in the development of industrial research training programmes • Undertakes research, development, and innovation in industrial and allied technologies • Develops an industrial research agenda based on Indigenous technical knowledge and contemporary and emerging issues • Disseminates and facilitates the application and commercialization of research findings and technological developments
Kenya National Innovation Agency (KeNIA)	• Supports commercialization of innovation • Facilitates a conducive legal environment for innovators and researchers • Promotes visibility of the innovation ecosystem
Kenya Bureau of Standards (KEBS)	• Provides quality control and approval of products coming out of HEIs
National Research Fund (NRF)	• Mobilizes resources for the national innovation systems from the Government, the private sector, venture capital, development partners, and other sources • Allocates funds for research and promotes multi-disciplinary collaboration among universities and research institutions • Provides financial support for the development of research facilities by universities, research institutions, and other bodies • Provides financial support and infrastructure for collaboration, cooperation, and sharing of research information and knowledge • Promotes liaison with bodies involved in the protection of intellectual property rights

Representatives from the government and HEIs indicated that the partnerships serve various purposes, including access to expertise, facilitating funding, dissemination of innovations, supporting the patenting of innovations, enforcing standards, incubation and commercialization of innovations, and community outreach. These key roles played by the different agencies are outlined in **Table 2**, above. Opinions from the respondents indicated a good working relationship between HEIs and government agencies, as illustrated by the quote below.

"I will use an example that I am involved in personally, which is the food fortification project we have been working on in collaboration with the government, the Ministry of Health, and the regulation bodies, particularly KEBS [Kenya Bureau of Standards], to bridge the gap in terms of knowledge in fortification as well as compliance. Because fortification is mandatory in Kenya."

– HEI Faculty Representative

The quote above illustrates a partnership between an HEI and a government agency in which the HEI contributes to strengthening the capacity of ATIE stakeholders, including processors, in food fortification innovations.

Partnership between HEIs and Public Research Organizations

Representatives of the government, HEIs faculty, and research organizations reported that partnerships between HEIs and public research institutions (such as KALRO and KIRDI) are driven by the needs of the partnering institutions and the individual HEI. They indicated that HEIs have existing partnerships in the areas of research, innovation, information/innovation dissemination, and outreach activities. For example, KALRO and KIRDI participate in joint training of research students and offer specialized training facilities, among others, to HEIs faculty and students. Other roles played by government research organizations are highlighted in **Table 2** above. The following quotes by representatives from HEIs and research organizations, respectively, demonstrate examples of the existence of partnerships between HEIs and public research institutions.

"We are working well with other research institutions. This is out of necessity since we are training students; we need partnerships with other research institutions to [provide specialized facilities and skills to students]."

– HEI Faculty Representative

While public research institutions offer specialized facilities and skills to some students from HEIs, a representative from a public research organization noted that their interactions with students are suboptimal because of the curriculum course requirement of short-term industry exposure, thereby

preventing them from fully participating in the institution's innovation processes as illustrated in the following quote.

> "In my case, for example, I work at a public research institution, and we collaborate with universities. However, sometimes, we have students working on a certain project for only a short time. This means that we don't take them through the entire process of developing that innovation."
>
> – Public Research Organization Representative

Partnerships between HEIs and the Private Sector

Representatives of the private sector and the government indicated that some level of partnership exists between HEIs and the private sector actors such as farmers, industry, and financial institutions. They expressed that partnerships have been developed in the areas of mechanization of agricultural processes, development and testing of prototypes, commercialization of innovations, and community outreach services. In these partnerships, which are generally occasional, HEIs conduct the research and industry test the prototypes. The industry takes new technologies and innovations to the market with an endeavor to commercialize them through its outlets and networks. The following quote by a government representative illustrates an example of partnerships between HEIs and industry.

> "There is the issue of working with the industry in terms of mechanization of agricultural processes. This includes [HEI researchers] coming up with new prototypes of machinery or equipment and working with the industry and linking them to the market."
>
> – Government Representative

However, representatives of HEI faculty observed that partnerships with the private sector were not working very well due to inadequate or lack of policies and frameworks for engagement. Indeed, HEI faculty observed that most HEIs lack policies, regulations and specialized units with staff dedicated to establishing and coordinating partnerships with the private sector. For instance, an HEI faculty expressed that HEI researchers are not adequately supported by their institutions to partner with the industry to

disseminate their research findings or support the commercialization of their innovations, as illustrated by the following quote:

> "We have more of a research approach method whereby we look for funds to do research, get the results, publish the findings, or share the findings with the industry for their action. However, within the university ecosystem, I don't think we have a special wing that looks for key industries and partners to promote our entrepreneurship products or innovations in the agricultural value chains."
>
> – HEI Faculty Representative

Furthermore, some representatives of the civil society that support farmers indicated that HEIs need to partner more effectively with farmers to ensure their research products meet farmers' needs. For example, one civil society actor emphasized the following:

> "We also [need] to […] have a needs assessment [...] through interaction with farmers, where farmers are able to air out the challenges that they have [...] I mean it could be a good innovation that is coming up from the university, but farmers do not have the capacity. Capacity here could mean maybe they don't have the skills or they don't have the resources to be able to implement or adopt the technology."
>
> – Civil Society Representative

In short, these research participants emphasize the need for HEI researchers to engage farmers to tailor their research to farmers' needs.

Partnerships between HEIs and Development Partners

Representatives of HEIs and civil society underscored the existence of strong partnerships between HEIs and development partners such as USAID, the European Union, the World Bank, Japan International Cooperation Agency, and the German Corporation for International Cooperation (GIZ). These partnerships and collaborations include student scholarships, exchange programs, research funding,

capacity strengthening, and support toward infrastructure and equipment. The following quote by a representative from the civil society illustrates how partnerships between HEIs and development partners contribute to HEI goals of educating and preparing students for the workforce and advancing research and innovation, which are key HEI roles in the ATIE.

> "[The University links] graduate student[s] with foreign governments…[so they can] go study abroad and…come back with improved innovations. If a person has an innovation, they sponsor that student or…link them with those foreign governments, and they are sponsored. [The student then goes on to] improve their innovation and …come[s] back to Kenya better [equipped] to implement that innovation."
>
> – Civil Society Representative

The quote above illustrates that partnerships between HEIs and development partners enable Kenyan graduates to access scholarships and fellowships to study abroad and further their knowledge, research, and innovation skills, which are essential to the development of the ATIE.

Development partners also invest in upgrading the ATIE infrastructure, which enhances the quality of research and innovation undertaken by faculty and students. The quote below by an HEI staff representative shows an example of an HEI research infrastructure development by a development partner.

> "We have several buildings which were constructed by the university, and we also have others supported by partners, like JICA [Japan International Cooperation Agency]. When you move to the rooms, you can see that most of the equipment to facilitate AgriTech were donated by JICA."
>
> – HEI Staff Representative

Partnerships between HEIs and Civil Society Organizations

Representatives of HEIs mentioned that there are some partnerships between HEIs and civil society organizations. They noted that, in the context of the ATIE, HEIs and civil society organizations partner on

various programs, including student exchange programs (attachments and internships), training and research, and joint workshops, conferences, seminars, and innovation exhibitions. HEI faculty indicated that the student exchange programs between HEIs and civil society organizations help expose students to real-world problem-solving, thereby making the students more innovative. During exchange visits, students are exposed to new methods of engaging with communities and disseminating research findings to farmers. The following quote by an HEI faculty representative, illustrates the benefits of partnerships between HEIs and civil society organizations.

> "We collaborate with other universities and other organizations, including NGOs in Kenya and beyond. Apart from student attachments, we also hold joint seminars and conferences. There are a lot of exchange visits with some of the institutions within and outside Kenya."
>
> – HEI Faculty Representative

In summary, there exist partnerships and collaborations between HEIs and other actors within the ATIE. HEIs collaborate and partner with other HEIs, the government and its agencies, public research organizations, the private sector, the civil society and development partners to carry out various activities including training, mentorship, idea incubation, research, fundraising, joint outreach activities, communication of research, and dissemination of innovations. While some notable partnerships exist between HEIs, the government and its agencies, effective collaboration and partnerships among HEIs is impeded by institutional bureaucracies. In addition, inadequate policies and frameworks for engagement affect partnerships between HEIs and the private sector. Further, while public research institutions offer practical training and experience to students from HEIs, their interactions with students is suboptimal which prevents students from fully participating in the entire innovation process.

HEI RESOURCE NEEDS

RQ 4: WHAT RESOURCES DO THE STAKEHOLDERS AT THE HEIs UNDER STUDY NEED TO BE ABLE TO ENGAGE EFFECTIVELY IN THE ATIE IN KENYA?

This research question seeks to bring to the fore respondents' perspectives and views on the resources needed by HEIs to engage effectively in the ATIE. The resources discussed include capacity strengthening for human resources, infrastructure and equipment, partnerships and collaborations, and financial resources. In addition, the challenges that HEIs face while accessing these resources are also presented.

Capacity Strengthening for Human Resource

Representatives from HEI faculty and staff, the government, the private sector, and the civil society mentioned that HEIs, especially the public ones, need adequately trained faculty and staff to respond to market needs, a dynamic ATIE, and associated challenges. Representatives noted that HEI faculty need capacity strengthening in research and development, and patenting of the resulting innovations. In addition, there is a need to strengthen the capacities of HEI students and faculty in the incubation of ideas, enterprise formation, and management and commercialization of innovations arising from research. For example, a private sector representative explained that while HEI faculty have deep expertise in their areas of study, they lack the skills needed to move from research to innovation and commercialization.

> "So I would say if you see many institutions… people are there and they know that they are competent in many different fields. But … do they have the skills and the knowledge that are needed to drive this thing of innovation and entrepreneurship? … I think we [are] more technically competent in some specializations, but not necessarily linking that to innovation… I see very little innovation coming from people who are truly very good in their area, whatever they learnt. But in terms of innovating and developing businesses that are not connected."
>
> – Private Sector representative

Further, there is a need for capacity strengthening in fundraising for research and innovations and capacity strengthening to improve the communication skills of HEI faculty for effective engagement in the ATIE, especially with the farmers. Many faculty also need training to get up to date with new technologies that have emerged. The quote below illustrates capacity gaps in the use of new technologies by HEI faculty.

> "I can say that some of our staff, including some of the professors, require training in some techniques. For example, for the new technologies in my field, such as nanotechnology genome editing and bioinformatics, you will not find many researchers who are conversant with new techniques coming up, which could help improve our innovations. So, we are limited, and the university, at the moment, cannot support [finance] those trainings."
>
> – Public HEI Faculty Representative

In addition to the training needs, respondents observed that the available human resource at HEIs faces a number of challenges, including low numbers of HEI faculty and staff and heavy workload related to teaching, examining students, administrative duties and research. These challenges are mainly due to limited funds to recruit additional staff and the natural attrition due to retirement and death.

> "All universities are up to the task, and they are motivated to carry out research and to teach. The only thing limiting them is the financing. Although they complain about the workload, they complain more about the budget. You can have an idea but fail to implement it because of the budgetary cost."
>
> – Civil Society Representative

On the other hand, representatives from the private sector mentioned that while HEIs produce graduates who are well-grounded theoretically, these graduates lack adequate practical skills to effectively participate in the ATIE. The quote below by an HEI researcher illustrates the need to include practical and field training in the curriculum to enable students to acquire practical skills that are relevant to their participation in the ATIE.

"Our graduates do not have adequate skills. Why I say this is because we do not have, apart from the normal, you know, cycle of going through the academic training, which is more of a theoretical approach. We really do not have a well-structured room whereby students can try out their skills and innovative ideas. So, we find that they may not do much in terms of Agritech because they do not have enough [of a] platform. As far as I know in terms of Agritech here, we only have the [lab] where there's so much going on, but then very few students get to participate."

– HEI Researcher

Conversations with public and private HEIs, government, private sector, and civil society show that retooling faculty for diverse skills in agriculture, training students on practical aspects of their curriculum, and supporting postgraduate research and incubation of ideas that can generate innovations leading to commercialization are essential for effective participation of HEIs in the ATIE. These were, however, seen to be dependent on the availability of finances.

Infrastructure and Equipment

Representatives from civil society, the government, and HEIs noted that HEIs need appropriate physical infrastructure, such as land, laboratories, and digital infrastructure (internet and digital platforms), in addition to equipment for analytics, processing, testing, extrusion, and packaging in order to innovate and fully participate in the ATIE. Representatives from different public HEIs confirmed that their institutions suffer from infrastructure deficiencies that manifest in a number of ways, including obsolete equipment and technologies, lack of modern laboratories, and specialized equipment to conduct modern research that addresses current issues. The quote below from a representative of a public HEI illustrates this need:

"When it comes to equipment, I would say our institutions are still not well prepared. If you visit our laboratories, you will find [the] equipment [...] [is] outdated or not modern. Most higher education institutions involved in the AgriTech space are public and, therefore, depend on the treasury [public funding]. And we all know that the government does not have adequate funding

for these institutions. This means that the equipment and facilities are wearing out and becoming obsolete."

– HEI Faculty Representative

On the other hand, representatives of HEIs mentioned that for the HEIs that have modern laboratories and equipment, the infrastructure is not big enough to accommodate the growing number of students. This undermines the quality of the innovative research and research output. The quote below from an HEI staff illustrates these deficiencies.

"Another major barrier is inadequate infrastructure. You can have a lot of students, but you don't have adequate infrastructure to accommodate all of them. For example, this laboratory was built to accommodate only 15 students. In the past, we used to have six or seven Master of Science students, but right now, I have 30. To accommodate them, we need to use the facility in shifts, which constrains the infrastructure."

– HEI Staff Representative

Institutional Initiatives and Support

Representatives from HEIs, civil society, and the government mentioned that institutional initiatives, including partnerships and collaborations between HEIs and other actors within the ATIE enhance research and innovation by mobilizing and sharing resources such as expertise skills, technical assistance, infrastructure, equipment, research funding, human resource capacity strengthening, fellowships to support postgraduate training, knowledge sharing, and the commercialization of innovations. A representative from an HEI opined that:

"Collaborations bring in resources, unique specialization, and infrastructure. What a university does not have can be obtained by collaborating with others. For instance, through the

collaboration between universities and the CGIAR center, postgraduate students access good research infrastructure at CGIAR, an international research organization."

– HEI Faculty Representative

Representatives of the HEIs, the government, and civil society opined that there exists weak institutional frameworks and linkages between HEIs and other ATIE actors, which affects the partnerships and collaborations. For example, one respondent mentioned that there are challenges related to ownership of the innovations that arise out of the collaborations and partnerships:

"If I collaborate..., if I'm a research institute, I collaborate with the University, then we come up with an innovation, who owns it? Is it, is it the person who is funding, maybe […] or is it [the university] who [is] doing [the research]…, or really the students who are really… working on it. So, I think that disconnect just leaves people in a precarious situation. Because maybe there is no policy that guides it."

– Private Sector Representative

Representatives of the HEIs, the government, and civil society advised that, for better engagement and commitment, partnerships and collaborations should be supported by clear and robust documentation (such as Memoranda of Understanding) and guided by clear policies that define the type and level of engagement between the HEIs and the ATIE actors. A representative of the private sector had this to say:

"If the universities don't have clear policies on how programs should exist and run, building collaborations and partnerships can be very limited. For me, I am in the field, and I don't think we have experienced that kind of collaboration."

– Private Sector Representative

Representatives from the private sector, the government, and HEIs pointed out the misalignment of research priorities between HEIs and other ATIE actors (including policymakers, funders, and the private

sector), which consequently leads to a mismatch in funding. For example, funds can be available within the ecosystem for financing a particular research goal that might not be part of the HEI's research agenda. In other words, there is a lack of clear avenues for the other ATIE actors to interact with HEIs regarding sharing information on priority areas for research and innovation as well as funding. In addition, representatives pointed at bureaucracy with lengthy processes, especially when it comes to public-private partnerships (PPPs), as a hindrance to establishing partnerships and collaborations.

Financial Resources

Representatives of HEI faculty, staff and students, civil society, and the government indicated that the key requirement for HEIs to fully participate in the ATIE is the availability of adequate funding for infrastructure and equipment, human resource training, and direct financing of innovative solutions right from ideation, conceptualization, prototyping, piloting, and scaling up. They observed that there is limited funding for training on skills such as resource mobilization, entrepreneurial skills, and how to use modern equipment. A representative of the civil society had this to say:

> "I think most innovations don't take place because they need a lot of funds to start, try out and learn, and then develop them. Universities should look for ways to mobilize funds such as seed money to enable students to innovate, undertake research on the innovation, and commercialize the innovation."
>
> – Civil Society Representative

Overall, the key resources required by stakeholders at HEIs to effectively engage in the ATIE include capacity strengthening for human resources, infrastructure and equipment, partnerships and collaborations, and financial resources. Several challenges faced by HEIs while accessing these resources have been highlighted. Key challenges include skill gaps, insufficient HEI faculty and staff numbers, heavy workload, infrastructure deficiencies (obsolete equipment and technologies, lack of modern laboratories and specialized equipment), and weak institutional frameworks and linkages between HEIs and other ATIE actors. Overcoming these resource constraints will require an investment of money and time as well as the buy-in of key HEI leadership to support these priorities for their institutions.

HEI RESOURCE PROVISION

RQ 5: WHAT ARE ECOSYSTEM ACTORS' PERCEPTIONS OF HEIs' PROVISION OF KEY RESOURCES NEEDED FOR STRENGTHENING THE ATIE?

This section presents views and perceptions of ATIE actors on the key resources provided by HEIs that are needed to strengthen the ATIE. The key resources presented include human capital for research and training, agricultural land and research infrastructure, and knowledge and information.

Human Capital for Research and Training

Respondents from HEIs, the private sector, civil society, and the government mentioned that HEIs provide skilled personnel for training, research, and innovation relevant to the ATIE. HEI actors train students, produce research-based innovations, and provide technical assistance to support AgriTech development. In addition, representatives indicated that HEIs play an active role in community outreach by training farmers and secondary school students. Representatives from the private sector and civil society mentioned that HEI actors have the capacity to undertake high-quality research and innovations that are trusted and respected by the public. A representative of the HEIs had this to say:

> "My university is one of the major universities we have, and it has the largest pool of trained professionals in agriculture. It contributes to the AgriTech space through training, carrying out research, and undertaking extension services. Training and research is the mandate of the university."
>
> – HEI Faculty Representative

Respondents from the HEIs observed that the availability of the human capital to contribute to research and innovation faces a number of challenges, including low numbers of HEI faculty and staff and heavy workload, as highlighted in RQ4 above.

Agricultural Land and Research Infrastructure

Representatives from civil society and the private sector mentioned that HEIs provide agricultural land and research infrastructure, including learning facilities, laboratories, machinery, and equipment that support research and innovation. They indicated that HEIs have adequate land used for experimentation and trials in breeding programs, running various enterprises, commercializing agricultural products, and community outreach activities, among other usess. Further, civil society representatives indicated that some universities provide incentives for innovation by renting out land to private firms, at low or no cost, to carry out experimentation and demonstrations. For example, private firms set up greenhouses for the development of crop seed varieties on HEI land, thereby lowering the cost of innovation. A representative from the civil society mentioned that:

> "I would say to innovate, you need both laboratory and field space. For example, if you are working with crops, you need a field to test your hypothesis or varieties that you have collected. The university has provided space for those who are interested at no cost, me being one of them. We do not rent the land. It is given freely as long as one expresses interest."
>
> – Civil Society Representative

Regarding research infrastructure, representatives from civil society and the private sector reported that laboratories are available to develop innovations. However, respondents intimated that the quality of many laboratories is not up to the standard and lacks the state-of-the-art technology to facilitate quality innovation. Respondents from HEI representatives further indicated that the laboratories and other infrastructure can only provide minimal support services to non-HEI actors since they are relatively few, as illustrated in the quote below.

> "I will give an example in my context. The equipment we use for research sometimes breaks down because of overuse. Due to financial constraints, you find one equipment being used by

people from other institutions. When it breaks down, all the work stops for all the universities using it. You find it is the only equipment available, and there is no money for maintenance."

– HEI Faculty Representative

Knowledge and Information Resources

Discussions with the representatives from the government, civil society, and public research institutions revealed that HEIs are valuable sources of knowledge and information that are utilized by actors in the ATIE. Such includes knowledge and information on incubation processes and experimental field testing (e.g., breeding of new crop and livestock varieties and processing of agricultural produce). HEIs provide this information in the form of books, e-resources, publications and manuals, and laboratory protocols, among others, which are accessible to the actors in the ATIE. However, respondents of civil society noted that access to knowledge and information is limited by the level of literacy of the actors, especially the farmers.

"Universities have quite a lot of information which they have documented and which I think has helped several innovations and several scientists to do their work. The information is in terms of publications and e-library."

– Public Research Institution Representative

"This institution, being a university with an agricultural foundation, is a knowledge bank in terms of agriculture and AgriTech. It has managed to teach farmers, particularly within the Kilifi and its environs, [about] agricultural processing. I'm aware of some women's self-help groups that have benefited from the knowledge from the university. Some of them are into coconut oil production, poultry farming, beekeeping, rabbit rearing, and smart farming using horticultural technology. "

– Civil Society Representative

Overall, the key resources that HEIs provide to other actors in the ecosystem include human capital for research and training, agricultural land and research infrastructure, and knowledge and information

resources. The study findings show that the provision of these resources is affected by challenges such as skill gaps; insufficient HEI faculty and staff numbers; heavy workload; and substandard infrastructure and equipment; all of which are partly due to limited financial resources.

POLICY

This section on policy and the regulatory environment is subdivided into two research sub-questions. The first sub-question presents views and perceptions of ATIE actors on the government policies, laws, and regulations that shape the incentives and disincentives for HEIs to engage in the ATIE. The second sub-question delves into views and perceptions of ATIE actors on the internal HEI policies and regulations that shape HEIs' engagement in research and innovation in the ATIE.

RQ6A: GOVERNMENT POLICY

HOW DOES THE POLICY/REGULATORY ENVIRONMENT SHAPE THE INCENTIVES AND DISINCENTIVES FOR HEI ENGAGEMENT IN THE ATIE?

Government Policies, Laws, and Regulations as Incentives

This question concerns the policy/regulatory environment (legal formation, tax implications of investment, intellectual property protection, level of policy responsiveness to emerging new fields and needs) and how it incentivizes and disincentivizes HEI engagement in the ATIE. Representatives of the HEIs and civil society reported that some government policies, laws and regulations create incentives for HEI participation in the ATIE. Such include the following:

- Universities Act of 2012: The Act provides for the establishment, accreditation, governance, quality assurance, and regulation of universities.
- Science, Technology and Innovation Act of 2013: The Act seeks to promote and regulate science, technology, and innovation (ST&I) in the country. The Act established the National Commission

for Science, Technology and Innovation (NACOSTI), which is responsible for overseeing and coordinating ST&I activities, particularly in terms of ensuring adherence to ethical standards. Key aspects of the Act include: Establishment of NACOSTI, Licensing of Research, Advisory Research Committees, and Registration of Research Institutes. The act also established the National Research Fund, which "mobilizes and manages financial resources to facilitate research for the advancement of science, technology and innovation for sustainable national development."

- National Agricultural Research System Policy: The policy seeks to facilitate coherency, consistency, and effectiveness of the national agricultural research policy, legal, regulatory and institutional framework to enable efficient coordination of the national agricultural research system. The policy also aims to:
    - coordinate planning, development, and management of knowledge, information and communication technology;
    - promote adoption, upscaling, and commercialization of agricultural research innovations and technologies and link research and industry to promote innovation and technology transfer and uptake
    - coordinate planning, development, and sharing of human resources and physical assets
    - strengthen investment and funding for agricultural research
    - increase focus on outreach, technology dissemination and targeted partnership.

Representatives of HEIs indicated that government agencies such as the CUE, NACOSTI, and KeNIA (highlighted in **Table 2**) support HEIs in the development of curricula that enable training students in different areas that are key to innovation. HEI faculty representatives mentioned that CUE is a critical government institution that regulates and ensures the quality of education programs, including those at the postgraduate level. Examples of programs, mentioned by the respondents, that are regulated by CUE in the agricultural sector include food processing and nutrition, and crop protection. During our interaction, an HEI representative stated that:

> "The agency that has been supportive is the Commission for University Education, which approves our academic programs at all levels from diploma to PhD. They approve new programs within a reasonable time, enabling us to start using them for training students in areas that address emerging problems."
>
> – HEI Faculty Representative

CUE also regulates the hiring of HEI personnel to ensure HEIs hire appropriately qualified individuals. The quote below attests to this:

> "Certainly, there are some good things that CUE has brought, for example, in terms of the staff who can be hired to work in higher education institutions. It's good because it ensures we have competent people and people with knowledge and skills, which helps to contribute to that innovation area in terms of developing and designing good programs for teaching. I think those are good things."
>
> – HEI Faculty Representative

Another government strategy mentioned is the Buy Kenya, Build Kenya, which seeks to introduce incentives to create an export-oriented economy, thus fostering local manufacturing and innovation. The strategy seeks to increase competitiveness and consumption of locally produced goods and services in both absolute figures and as a proportion of the gross domestic product by providing support to local producers, such as through subsidies, capacity building, reserving at least 40% of public procurement for local goods and services. However, actors did not identify this strategy as a government incentive for HEIs' engagement in the ATIE. This is because the strategy has achieved little yet in terms of providing incentives for exports since imports far still outweigh exports in the Kenyan market. Generally, it was observed that the incentives provided by the government in the National Trade Policy coupled with cheaper imports have limited the Buy Kenya, Build Kenya strategy, according to an HEI faculty representative, as illustrated by the following quote.

"It is a different story to have the policy [Buy Kenya, Build Kenya] and a totally different story if the policy is not implemented. Because if what is produced locally is going to compete with cheaper imported goods, then in that context, we will just be killing both the human aspiration to do the production and also our economy"

– HEI Faculty Representative.

Government Policies and Taxes as Disincentives

Representatives from HEIs and civil society mentioned that some government policies and laws create disincentives for HEIs to fully engage in AgriTech research and innovation. Such policies and laws include the National Tax Policy, the Finance Act (amended every financial year)[11], and the National Trade Policy.

Several respondents highlighted the numerous barriers Kenyan startups face. The respondents opined that these policies and laws impose fees and taxes (such as registration fees, quality standards licenses, annual licenses, income tax, withholding tax, and value-added tax) on start-ups without a grace period, and taxes on raw materials, increasing the cost of production and making the end products less competitive. For example, one respondent mentioned that multinational companies and startups pay the same taxes:

"The tax regime does not in any way recognize or encourage current startups. [...] [I]t's an uneven playing field when it comes to tax, currently [...] Even the inputs [...] are not given any exemptions, they're still taxed. [...] That in itself is a hindrance."

– HEI Faculty Representative

Start-ups also face lengthy and costly procedures for licensing, patenting, and standardization of innovations. For example, one faculty member spoke about the lengthy and costly bureaucratic processes of licensing being an important impediment to commercialization:

[11] The National Tax Policy and the Finance Act are amended at the start of every financial year with occasional adverse impacts (such as increased production costs) to the ATIE.

"When a venture starts, so you're moving from research, thinking of a product, then going the way of a venture into business, you have to have licenses [...] there are different entities that need to do this [licensing process]. A lot of it. Of course, you have to pay, you know, you have to pay for all these things."

– HEI Faculty Representative

In addition, respondents highlighted government policies that encourage the importation of raw materials and cheap, low-quality products that compete with locally manufactured products to negatively impact local production, thereby demotivating the HEIs and other actors to innovate. A representative from civil society stated that:

"The business environment is very tough due to the taxes imposed on businesses. If a university or another innovator wants to register a product, manufacturing, and fabrication of that innovation is quite expensive. By the time such a product reaches the final consumer, its price is too high compared to existing similar products on the market. Therefore, most innovators would rather register, manufacture the product abroad, and bring it into Kenya, avoiding the taxes that come along the value chain."

– Civil Society Representative

Further, representatives from HEI faculty mentioned inadequate government funding for research as one of the barriers to HEI's full participation in the ATIE. While the Science, Technology and Innovation Act indicates the government should allocate at least 2% of GDP toward research, the government has not fully implemented this policy. HEI faculty representatives brought up the failure to implement this policy as an important barrier to HEI engagement in the innovation ecosystem. Below is a statement from one of these respondents:

> "For example, it says that you need to have at least [2%] of the GDP put aside for research. But in actuality, we don't even give less than one percent. So, it's not the regulations that are inadequate. So I think it's the implementation of those regulations that are actually inadequate."
>
> – HEI Faculty Representative

Indeed, in its assessment of Research and Innovation in Kenya, UNESCO (2023) reported that national expenditure on research and development was at 0.8%, well below the country's target of 2%.

In summary, the government has established a legal, regulatory, and institutional framework that supports the engagement of HEIs in the ATIE. This framework includes policies and laws such as the Curriculum Development Policy, the National Science, Technology and Innovation (ST&I) Policy, the Universities Act of 2012, the Science, Technology and Innovation Act of 2013, the Commission for University Education Act of 2012, and Buy Kenya Build Kenya Policy. In addition, various government institutions and agencies, including NACOSTI, and KeNIA, facilitate HEIs' engagement in ATIE.

However, some policies, laws, and regulations act as disincentives and, therefore, hinder the effective engagement of HEIs in the ATIE. Such include tax and trade policies that create costs in the form of fees and taxes, lengthy procedures for licensing and standardization of innovations, competition for startups by promoting the importation of raw materials and cheap low-quality products, and inadequate government funding for research.

RQ6B: HIGHER EDUCATION POLICY

HOW DO HIGHER EDUCATION INSTITUTIONS' POLICIES INFLUENCE THE INCENTIVES AND DISINCENTIVES FOR HEI ENGAGEMENT IN AGRITECH INNOVATION ECOSYSTEM?

RQ6b concerns how HEI policies influence HEI engagement in the ATIE (e.g., faculty and students' proclivity to engage and business interest in collaborating with HEI stakeholders to meet innovation needs).

Internal HEI Policies as an Incentive

Representatives from HEIs and civil society mentioned that HEIs have internal policies that guide research and innovation, and such policies are informed by the national government policies, laws, and regulations, especially the Universities Act of 2012. The mentioned policies include the Human Resource Management Policies and Procedures[12] that peg staff promotion to teaching, student research supervision, research and/or innovation, highlights workload distribution, and those that support innovation like policies for patenting. Respondents intimated that while these policies provide incentives for research and innovation, there are challenges to the implementation of these policies.

Pegging staff promotion to research and innovation

Representatives of HEIs faculty indicated that internal HEI human resource management policies and procedures motivate the faculty and staff to undertake research and innovate by pegging promotions on the number of scholarly publications, research grants, new innovations, and patents. This contributes to new evidence, knowledge products, and innovations that are important for the growth of the ATIE. On the other hand, representatives of the civil society opined that HEI faculty, staff, and students prioritize basic research (that does not lead to innovations) over innovative research. While discussing the role of internal HEI policies on innovations, an HEI faculty representative stated:

> "The motivation to engage in research that can lead to technology and innovations is very high. This is anchored on the policy of the university, where one can only be promoted after attaining a certain level of research evidenced by the number of research publications. Every member of staff is keen to move from one level to another."
>
> – HEI Faculty Representative

Workload distribution

Representatives of HEI faculty mentioned that internal HEI human resource and management policies and procedures require faculty and staff to regularly engage in research and innovation in addition to teaching, carrying out administrative duties and community outreach activities. However, respondents from different HEIs had diverse views on workload distribution. While work distribution policies offer opportunities to faculty and staff to conduct research and innovation activities, some HEI faculty opined that too much time is devoted to teaching and administrative work, leaving little time to conduct research

[12] Each HEI has its own promotion policies.

and innovations. For example, in the following quote, a representative from the HEI mentioned that 40% of faculty time is supposed to be spent on research.

"The university policy on work distribution has a 40: 40: 20 allocation system. It means that you allocate 40% of your time to teaching, 40% to research and 20% to administration. So, automatically, the university don has been given an opportunity to do research. That is supportive because almost half the time they are in the university, they are expected to engage in some form of research to come up with technologies to help the society."

– HEI Faculty Representative

However, some faculty indicate that the heavy teaching load leaves little time for research. For example, one HEI faculty member indicated:

"The workload policy in most universities may not support innovations because it tends to go very much to the core mandate ... So, of course, for you to innovate, you need time and that has been a big debate among workers. Of course, you need time to do that, but …[most faculty's] time is dedicated to teaching and learning."

– HEI Faculty Representative

Internal HEI Policies as a Disincentive

Representatives of HEIs and the government mentioned that some sections of the HEI research and innovation policies discourage faculty and staff from undertaking research and innovation. For example, intellectual property ownership and royalty-sharing arrangements of commercialized innovations and research outputs are viewed as unfair to the researchers and innovators as they are largely skewed in favor of the HEIs. The respondents also highlighted the lack of support given to innovators to commercialize research products and innovations.

Royalty-sharing arrangements

Representatives of the HEIs opined that the royalty-sharing arrangements in HEIs are developed in such a way that the institution that hosts the innovation gets a share of benefits from the commercialized innovation products.[13] Some of the HEI representatives added that the institutions take quite a disproportionate percentage of the accrued benefits. Yet, in some instances, faculty staff use their own funds to undertake research and innovation and to process the patent fees. The high share of benefits to the institutions discourages the faculty and staff from actively engaging in the ATIE. In addition, Occasionally, some faculty members have to fund their own research to some extent.

> "You invest a lot of your money and time to achieve an innovation and when it is done, the institution asks for 40% share of the proceeds, arguing that you are using their facility. Why don't they ask for 10% in terms of royalty? Forty percent is too high"
>
> – HEI Faculty Representative

On the other hand, representatives from the government supported the benefits-sharing arrangements, arguing that since innovators derive benefits from the host institutions, it is justified for the institutions to share in the accrued benefits, as illustrated in the following quotation.

> "Well, I know, in terms of IP [intellectual property], that is what usually happens. If you are within the system and you generate a product, why not share the benefits? Since you are working within a system and benefiting from it, I don't think you have grounds to complain."
>
> – Government Representative

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[13] The World Intellectual Property database lists the intellectual property policies for four universities in Kenya, which show a wide range in royalty sharing from Universities collecting as much as 60% of royalties to as little as 20%. The University of Nairobi provides the following royalty sharing arrangement: 40% to the inventor, 25% to the College/School/Department/ Institute/Laboratory/Library, 30% to the intellectual property management office, and 5% for the endowment to the intellectual property management office. Royalty sharing at Mount Kenya University is as follows: 30% inventor(s), 10% collaborator(s), 60% for the university. The percentage researchers at Kenyatta university receive from royalties range from 80% for royalties that do not exceed one million Kenyan shillings, to 50% for royalties that exceed five million Kenyan shillings, with the universities receiving the remaining 20% to 50% of royalties. Moi University, on the other hand does not indicate what the distribution of royalties would be, but says a determination would be made by the University Senate and approved by the Council.

While in most parts of the world, universities take a large share of royalties from commercialized inventions originating from work produced by researchers at their universities, in cases where researchers' salaries are already low, financial incentives are likely an important motivator. Thus, the appropriate distribution of financial incentives is important to consider when determining intellectual property policies (WIPO, 2024).

Commercialization of research and innovations

Representatives of HEIs reported that in addition to unfair benefit-sharing arrangements, commercialization of innovations remains largely untapped due to the absence of clear policies. Representatives also noted that where policies on commercialization exist, they face implementation challenges due to the absence of dockets dedicated to the operationalization of the policies and limited funds allocated for their implementation. Representatives observed that these shortcomings limit the full participation of the faculty and staff in the commercialization of innovations. The following quote from a HEI actor while consulting on the role of HEIs' internal policies on innovations illustrates the impact of a lack of policy implementation on commercialization:

> "We have a policy document, but it is not operationalized at all. Right now, we have a Director, an IP Officer, and two or three support staff. When you think about what needs to be done around commercialization, from contacting faculty and identifying potential inventions and examining them to identify minimum viable products for prototyping. The human resource is not enough. So, really, there's nothing around commercialization."
>
> – HEI Faculty Representative

Representatives of HEIs viewed that internal policies on the promotion of staff and workload distribution incentivize faculty and staff engagement in innovations. However, policies on sharing of benefits accruing from innovations and the lack of implementation of commercialization policies were seen as constraining to innovation.

MARKET

RQ 7: HOW DO MARKET-RELATED FACTORS IN KENYA SHAPE OPPORTUNITIES FOR HEI ENGAGEMENT IN THE ATIE?

This section presents the views and perceptions of respondents from the HEIs, the government, research institutions, the private sector, and civil society on how market-related factors in Kenya shape opportunities for HEIs' engagement in the ATIE. In general, respondents indicated that Kenya has a relatively vibrant and dynamic market that is conducive for many start-ups, entrepreneurs, and investors involved in developing and adopting new technologies and solutions for agriculture. However, respondents noted that some policies on taxation and trade, competition from the already established and large companies, and consumer preference for imports due to their price competitiveness negatively affect the operations and growth of AgriTech start-ups, including those run by HEIs.

High Demand for Products and Services from HEIs

Representatives from the private sector and HEIs mentioned that the Kenyan market offers HEIs a fairly conducive environment in which to engage in the ATIE. Respondents highlighted a high demand and consumer preference for innovative products and services produced by HEIs as an incentive for their participation in the ATIE. They opined that consumers generally trust the products and services produced by HEIs, which enhances the vibrancy of the ATIE. Additionally, representatives from the private sector indicated that the skilled human capacity, research outputs, innovative products, and services incubated at Kenya's HEIs are not only demanded domestically but are exported to the regional markets, including countries within the East African Community. Such products include crop and livestock products, digital products, irrigation technologies, and greenhouse machinery and equipment. Respondents emphasized that not only do consumers trust the quality of the products, but they also remain loyal to the brands. This provides a ready market for products and services developed and commercialized from the HEI incubation hubs.

"This being an agricultural institution, the consumers out there look up to us, and they have faith and belief in the quality of whatever we produce. The uptake of whatever we produce and sell to the community is high. Be it in the ecosystem or be it in [the] improvement of the management of an organization, finances, or new innovations."

– Civil Society Representative

"I am going to talk from the market perspective because most of the things that we do, such as greenhouses and irrigation systems, you find most of the East African countries coming here to get the technology. So, I would say we are medium because Rwanda, Uganda, and Somalia keep on engaging us for these kinds of services."

– Civil Society Representative

The high demand for products and services from HEIs highlighted by the respondents underscores the significant role that HEIs can play in the ATIE. This implies that HEIs need to tap into the opportunities that the market offers for them to fully engage in the ATIE.

Competition from large companies and cheap imports

Representatives from civil society, the private sector, and HEIs reported that HEIs' engagement in the ATIE is negatively affected by some market factors, such as competition from already established large companies faced by start-ups. In addition, respondents highlighted the perceived unfair taxation and importation policies where start-ups (some of which are linked to HEIs) face the same tax and fee regimes as the established companies, as well as the competition from cheaper commodities as discussed in research question six.

Respondents emphasized that despite the government policy initiatives of promoting start-ups through the KeNIA, the competition from bigger companies is a threat to the survival of start-ups and stifles the

commercialization of innovative ideas from HEIs, as illustrated by the quote below from a government representative.

> "I think the environment is not very conducive. Considering that businesspeople import things which are cheaper and support foreign technologies. That is the greatest thing we have through that policy [trade policy]. It is easier to import, even maize, GMO [genetically modified organism] than supporting a local breeder to develop a variety."
>
> – Government Representative

Civil society, government, and HEI representatives view Kenya as endowed with a relatively vibrant and dynamic market for ATIE. Innovative products and services from HEIs are valued and trusted by local consumers. Some of these innovations, including greenhouses, irrigation, and digital technologies, have found a niche in the East African market. However, other market-related factors constrain the effective participation of HEIs in the market, such as competition from bigger companies and cheap imports.

CULTURE

RQ8: HOW DO CONTEXT-SPECIFIC NORMS, PERCEPTIONS, AND VALUES AFFECT HEI ACTORS' PROCLIVITY TO ENGAGE IN THE ATIE?

This section presents views and perceptions from representatives from HEIs, the government, civil society, and the private sector on how cultural norms, perceptions, and values affect the participation of HEIs in the ATIE. Respondents highlighted five key areas in which culture affects the participation of HEIs in the ATIE: (1) trust in HEIs' ability to innovate; (2) attitudes towards new technologies; (3) attitudes

towards employment in agriculture; (4) communication barriers between HEI faculty, staff, and farmers; and; (5) biases based on gender and age.

Most Trust in HEIs' Ability to Innovate, Though Some Claim Farmers Have Negative Attitudes Toward New Technologies

Representatives of the government and the private sector mentioned that they have high regard for HEIs in providing AgriTech solutions because of their ability to produce research and innovation. The respondents emphasized that the university faculty, staff, graduates, and their innovations are highly esteemed and trusted by stakeholders within the ATIE. The trust and respect accorded by non-HEI actors to HEIs motivates them to engage and create innovative solutions for the agricultural sector, as illustrated by the quote below from a government representative.

> "When I think about the [...] a public University, it has been there for a very long time, and this gives them an edge. They have a name that is trusted, so people tend to go back there for solutions. So, when people need solutions or are looking for who to work with, and whose output they can trust because it is tested and tried, one of the places that they go to is the [...] public University."
>
> – Government Representative

Respondents appreciated the role evidence-based research undertaken by HEIs plays in the innovation processes, as illustrated by the quote from a private sector representative below.

> "The institutions of higher learning have done a lot of research. If something [an innovation] is backed by research that has been done by a university, it will get a lot of respect in our society, just as our colleagues have said. Our society respects university education."
>
> – Private Sector Representative

However, some respondents indicated that some actors do not take up HEI technologies meant for farmers due to negative attitudes.

Some respondents opined that society prefers traditional technologies to new ones, which is a disincentive for HEIs to fully participate in the ATIE. For example, respondents mentioned that when it comes to crop varieties, some farmers prefer varieties they have replanted over the years to new varieties produced by HEIs despite their advantages, such as high yields, pest and drought resistance, and high nutritional value, as mentioned by an HEI representative in the quote below.

> "You may realize that Kenyans have very good innovations, including very good crop varieties like the hybrid maize 614. However, because of the attitude and behaviors, adoption of some of those innovations remains very low."
>
> – HEI Faculty Representative

The views expressed by the respondents point to the fact that the adoption of new technologies and products can be slow due to tastes and preferences that end-users have acquired over time or a fear of risks associated with new innovations. This is emphasized in the quote below.

> "I am working with cassava for my PhD. We have some transgenic cassava which has a low amount of hydrogen cyanide that has been developed by KALRO and other universities. But when you take this variety to the people, they do not accept it. Why? They say it does not go with their culture and that it is just flat [tasteless]. So, it has a low uptake, yet it has low cyanide content. They would prefer to have the traditional varieties that have high cyanide content, which is also not very good, and it is dangerous."
>
> – Government Representative

However, as mentioned under RQ3, some civil society actors who work with farmers argue that low uptake of HEI innovations among farmers is due to their lack of engagement with farmers when developing innovations. Below is another quotation from a civil society representative illustrating this:

> "I think the higher education institution in order to make sure that the research they do [...] [is] very effective, especially in relation to value addition, that is in the industry and also in production where we have the farmers, and considering that 75% of farmers in Kenya are small-scale farmers

who mainly cannot afford the high technology [...], I think [it would be] good [that] they go down to these farmers, they find out before they come back and now do those innovations [...] Because you find a technology, yes it is good, but this small-scale farmer cannot afford [it] and therefore it is [use]less to this small-scale farmer [...] I think it will be very fruitful if the researchers [...] go down [consult farmers]."

– Civil Society Representative

Negative Attitudes Towards Employment in Agriculture

Representatives of the civil society and HEIs opined that graduates of agriculture-related programs prefer white-collar jobs outside the agricultural sector. Respondents associated this attitude with inadequate exposure of students to technical field practice during the training. This negative attitude towards employment in agriculture deprives the ATIE of valuable expertise and skills. For example, representatives from the private sector reported that agribusiness entrepreneurs face challenges in recruiting graduates with the passion to work in the areas of agricultural processing.

On the other hand, some representatives of civil society, the government, and HEIs mentioned that the agricultural sector does not offer many attractive employment opportunities to graduates. Respondents opined that the lack of employment opportunities is a disincentive for students interested in pursuing agriculture-related academic programs. This discourages HEIs from providing degree programs and course offerings on agriculture. A representative from the civil society stated that:

"There is a culture of people graduating and going looking for white collar jobs [that are outside the agricultural sector]. Most students do not practice what they studied in college. This has been a result of our education system, where from primary school if somebody makes a mistake, he or she is given a *jembe* (hoe). So, agriculture is viewed as a punishment. Most students hate agriculture, and by the time they graduate from the public universities with a degree in agriculture, within their hearts, they don't want to go and practice what they were taught. So, we need to change that."

– Civil Society Representative

HEI Faculty and Staff Seen as Inaccessible

The representatives from the private sector indicated that some ATIE stakeholders, especially farmers, perceive that HEI faculty and staff are sometimes inaccessible due to the scholarly language they use when communicating new crop varieties or technologies. Respondents emphasized that ordinary farmers think university faculty and staff do not interact with people who are not their peers. Such perceptions and stereotypes limit the transfer of knowledge and engagement between HEIs and other actors, such as farmers within the ATIE. However, farmers directly communicate with HEI faculty during on-farm demonstrations and community outreach events. A representative from the private sector mentioned that:

> "A common barrier is that people outside the university often distance themselves from the institutions [HEIs]. The reason is that people find it intimidating to talk to professors. They assume that the professors will look down upon them. Maybe I am not learned enough and all that. So, people may shy away from collaborating with universities. In the agriculture space, you find that most of the people who engage in the sector are not that learned. They are literate enough but not quite learned. They usually feel intimidated and shy away from some programs."
>
> – Private Sector Representative

Gender and age norms limit the effectiveness of HEI support for women and youth

Representatives from civil society and the government reported that some traditional beliefs are biased against women and the youth, preventing them from making decisions without consulting their male counterparts or parents and caregivers. The respondents emphasized that the patriarchal nature of some Kenyan communities gives men an upper hand in decision-making regarding the control of agricultural land, means of production, and proceeds, despite the women and the youth constituting the largest proportion of the rural agricultural labor force. Such biases reduce the opportunities for HEIs to meaningfully engage directly with the women and the youth or interest them in fully participating in the ATIE. A representative from the government had this to say.

> "I want to bring attention to the issue of social fabric. In some communities, women and the youth who want to start up a business need to get permission from the patriarch, the family, and

all that. You find that even someone who is very innovative can fail to access funds due to lack of collateral or space because ownership is controlled by someone else."

– Government Representative

Mistrust – Fear of Intellectual Property Theft

Finally, several HEI actors reported fear of intellectual property theft by staff of government agencies charged with registering innovations. They worried that public officials might steal the innovations and sell them to other parties. For example, one HEI actor explained the following:

" … I think the regulatory bodies need to reach the general mankind [public] so that they know exactly where to run to in case one has got an innovation without the fear of losing that creation, because there is some corrupt person in some office who will tell him or her, can you bring your innovation or the write-up, and then that person runs away with it. [We therefore need] to have a system [that can be trusted]. Ahh I think the bigger word here is trust and protect Kenyan innovations."

– HEI Faculty Representative

This level of mistrust, particularly in Kenya, is a huge inhibitor to the production and commercialization of innovations that need to be addressed.

In summary, widespread trust in the ability of HEIs to innovate motivates HEIs to engage and create innovative solutions for the ATIE. On the other hand, negative attitudes towards new technologies and employment in agriculture, communication barriers between HEI faculty, staff, and farmers, biases based on gender and age, and fear of intellectual property theft act as disincentives for HEIs to participate fully in the ATIE.

RECOMMENDATIONS

RECOMMENDATIONS FOR THE GOVERNMENT OF KENYA

1. **Review and reform government policies, laws and regulations on trade and taxation:** The government should revise policies, laws and regulations on taxation and trade to include measures that protect AgriTech start-ups from competition arising from imports, streamline procedures for licensing and standardization of innovations, and reduce associated costs.

2. **Revise licensing and standardization procedures and fees:** The government should revise the procedures and fees for licensing startups and standardization of innovations to avoid lengthy processes and associated costs.

3. **Increase funding to public HEIs for AgriTech research and innovation infrastructure development:** Increase funding to public HEIs to support upgrading and setting up new infrastructure such as modern laboratories and specialized equipment to facilitate cutting-edge research and innovation within the ATIE.

4. **Fulfill the funding requirements of the Science, Technology and Innovation Act of 2013:** As of 2023, the government was only investing 0.8% of GDP in HEI research - well short of the 2% outlined in this policy (UNESCO, 2023). Government funding for HEI research could go a long way to spur additional research to support the ATIE, especially in sectors research participants labeled as underdeveloped, such as water management, agricultural processing, and livestock. Consider initiatives that incentivize private sector actors to co-fund research with the government, such as matching grant opportunities.

5. **Develop and implement a national intellectual property policy, streamline intellectual property application procedures, and institute e-government intellectual property applications to reduce opportunities for corruption:** UNESCO (2023) notes that Kenya lacks a national intellectual property policy and the current legal instruments for protecting intellectual property are not "harmonized." Also, research participants indicated that the process for registering intellectual property, such as patents, is lengthy and costly, and five HEI respondents indicated fear of intellectual property theft during the process from public officials charged with processing applications. Creating a harmonized intellectual property policy, streamlining application procedures, and instituting an e-government application process can help address these barriers to intellectual property registration.

6. **Operationalise policies, laws and regulations, and to prevent gender and age discrimination:** The government should operationalise, review or reform existing laws, policies and regulations to curb any form of discrimination that prevents women and the youth from meaningful engagement with HEIs and their full participation in the ATIE.

RECOMMENDATIONS TO HEIS

7. **Create revenue mobilization strategies for AgriTech research and innovations:** HEIs should create strategies including grant writing, partnerships and collaborations, and other income generating activities aimed at mobilizing funds to support AgriTech research and innovation.

8. **Increase promotion and dissemination of new AgriTech solutions:** HEIs should increase their promotion and dissemination efforts of technologies and innovations to reduce negative attitudes towards new technologies and ensure increased adoption by end-users. Communication messages and channels should be tailored and segmented to reduce communication barriers and reach different audiences within the ATIE.

9. **Undertake research on barriers to uptake and adoption of new AgriTech innovations:** HEIs, working together with the government and other actors in the ATIE, should carry out social norms and behavior change communication research to understand barriers and facilitators to farmer uptake of Agritech solutions and effective communication channels and messages to shift farmer behavior.

10. **Streamline and strengthen institutional frameworks and policies for partnerships and collaborations with other ATIE stakeholders:** Refine and strengthen institutional frameworks and policies to reduce institutional bureaucracies in order to promote partnerships and collaborations in areas of fundraising, research, innovation, infrastructural and skills development with other actors within the ATIE.

11. **Promote research commercialization:** Review and design policies and strategies to set up or strengthen specialized units dedicated to research commercialization, and tailor HEI policies to effectively incentivize faculty and staff to engage in research and innovation. Consider the World Intellectual Property Organization's guide on how to identify the appropriate mix of incentives within a given context: Incentives in Technology Transfer A guide to encourage, recognize and reward researchers and professionals (WIPO, 2024).

12. **Build capacity of HEI faculty and staff in research and innovation processes:** HEIs should carry out capacity assessments to identify skill gaps in research and development, innovation patenting, incubation of ideas and enterprises, commercialization of innovations, fundraising, soft skills, and dissemination and offer necessary capacity strengthening trainings.

13. **Develop faculty promotion policies that reward faculty innovation and research impact** and uptake to incentivize faculty alignment of research and innovations with the needs of end-users, such as farmers and private sector actors.

14. **Merge agricultural academic programs with other in-demand courses:**[14] Given the low interest in youth engagement in agricultural courses, merging agricultural courses with other in-demand courses can help attract more young people to the sector.

[14] This idea emerged from participants who attended the HEIGHTS IE research findings validation session in Indonesia, but may be a transferrable idea to the Kenyan context.

CONCLUSION

In summary, research participants indicated that the ATIE in Kenya is at a medium level of development and is characterized by HEIs producing valuable innovations to address key challenges, such as climate change. HEIs have valuable partnerships with HEIs in other countries to carry out research, and donor organizations are providing funding to support research, infrastructure, and exchanges.

The national government can support HEI engagement in the ATIE by creating national intellectual property and commercialization policies and streamlining regulatory agencies, as well as reducing taxes and streamlining business registration processes for Kenyan startups to enable them to compete with cheap imports.

HEIs can enhance faculty, staff, and student engagement in the ATIE by recognizing faculty innovations and extension work within promotion criteria and investing in the human resources needed for their technology transfer offices.

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ANNEXES

ANNEX 1: CONSENT FORM

Consent Form: Key Informant Interviews (KIIs)
Higher Education Institution Engagement in Innovation Ecosystems - Kenya
Principal Investigators: Prof. John Muthama (University of Nairobi -UoN) and Dr. Fernanda Soares (University of Notre Dame -UND)

ABOUT THIS CONSENT FORM

You are being asked to participate in a research study. This consent form will give you information about the study to help you decide whether you want to participate. Please read this form carefully and ask any questions you have before agreeing to be in the study.

WHY IS THIS STUDY BEING DONE?

The purpose of this study is to explore how higher education institutions, across their many forms, can positively influence an innovation ecosystem through a variety of roles while taking into account limiting factors like resources, relationships, and social norms.

You were selected as a possible participant because you were identified as a key act8or in the Agritech innovation ecosystem in Kenya, where the study is being conducted.

The study is being conducted by the University of Notre Dame, the Resilient Africa Network (RAN), and The University of Nairobi. It is funded by the United States Agency for International Development (USAID).

TAKING PART IN THIS STUDY IS VOLUNTARY

You may choose not to take part in the study or may choose to leave the study at any time. Deciding not to participate, or deciding to leave the study later, will not result in any penalty. Your participation is not a part of your work requirements.

HOW MANY PEOPLE WILL TAKE PART?

If you agree to participate, you will be one of 5 participants taking part in this study.

WHAT WILL HAPPEN DURING THE SEMI-STRUCTURED INTERVIEW?

If you agree to be in the study, you will be asked to participate in a semi-structured interview, which will last approximately 90 minutes. During this interview, we will ask you questions about Higher Education Institutions engagement in the Agritech innovation ecosystem in Kenya. If you agree, our team will audio record the activity so we can prepare typewritten notes afterward.

WHAT ARE THE RISKS OF TAKING PART IN THE STUDY?

There is a risk that you might be uncomfortable answering some of the questions. At any point during the semi-structured interview, you can tell us that you feel uncomfortable or that you do not want to answer a particular question. You can stop participating in the interview at any time.

There is a small chance that you may be identified based on the quotes you provide during the interview. We would like to ask for your permission to use quotes that you may provide during the interview. **Your name will not be shown.**

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THE STUDY?

We don't expect you to receive any benefit from taking part in this study, but we hope to learn more about things that work in the engagement of Higher Education Institutions in Innovation Ecosystems in Kenya to strengthen Higher Education engagement in your country.

HOW WILL MY INFORMATION BE PROTECTED?

The research team will be careful in ensuring your personal information is kept confidential. We cannot guarantee absolute confidentiality. No information which could identify you will be shared in publications about this study.

If you agree, we will audio record this conversation to review your responses and record them anonymously in our database. If names or other identifying information is found in the audio recordings it will not be added to our study notes. The audio recording from the interview and transcription files will be saved on an encrypted cloud-based folder on Google Drive for 3 years after the end of the data collection.

WILL MY INFORMATION BE USED FOR RESEARCH IN THE FUTURE?

Your information will not be used or distributed for future research studies.

WILL I BE PAID FOR PARTICIPATION?

There will be no compensation for participating in this study.

WHO SHOULD I REACH OUT TO WITH QUESTIONS OR PROBLEMS?

For questions about the study, you can contact the Principal Investigators, **Prof. John Muthama** on email (jmuthama@uonbi.ac.ke) or phone 0710244438 OR Dr. Fernanda Soares through fassunca@nd.edu

For questions about your rights as a research participant, to discuss problems, complaints, or concerns about this study (Protocol Number **NACOSTI/P/23/23104** - UoN and 22-08-7370 UND), please contact Notre Dame Research Compliance at 574-631-1461 or at compliance@nd.edu

PARTICIPANT'S CONSENT

In consideration of all the above, I give my consent to participate in this research study. I will be given a copy of this informed consent document to keep for my records. I agree to take part in this study.

Participant's Printed Name:_____

Participant's Signature:_____**Date**:_____

Printed Name of Person Obtaining Consent:_____

Signature of Person Obtaining Consent:_____**Date**:_____

ANNEX 2: KII GUIDE WITH HEIs

Key Informant Interviews: Semi-structured Protocol

HEIs' Engagement in Innovation Ecosystem, *Kenya*

Interview Date:
Interviewer name:
Respondent name:
HEI:
Role-position within HEI:
Introduction

Greetings and thank you for agreeing to participate in this interview. My name is _____. I am a researcher with _____ collaborating on a study about the engagement of Higher Education Institutions in the Kenya AgriTech innovation ecosystem.

The purpose of this study is to explore how higher education institutions, across their many forms, can positively influence an innovation ecosystem through a variety of roles while taking into account limiting factors like resources, relationships, and social norms. We are using the term "ecosystem" to describe the set of organizations and individuals that are involved in developing and supporting innovations related to the AgriTech innovation ecosystem in Kenya. By "innovations," we mean the introduction, development, and operation of new value-added products, services or new and improved processes in the social and economic spheres.

The purpose of our interview today is to gather information about how your HEI is or is not engaging in this ecosystem as well as enablers and barriers that have facilitated or constrained this engagement. We selected your HEI to be part of this study because of its key role in the AgriTech innovation ecosystem. Within your HEI, we selected a few key informants that are engaged in innovation activities.

The interview will last approximately 90 minutes. Did you read the consent form? Do you have any questions? [NOTE TO INTERVIEWER: collect signed consent. If any participant refused to grant consent, thank them for their time and advise that they are free to leave].

Ice breaker

Let us start by discussing your involvement in the AgriTech innovation ecosystem. Could you tell me in what ways have you engaged with or contributed to AgriTech innovation activities in Kenya?

RQ2: HEI's roles

2.1. Would you say University of Nairobi is a critical contributor, a somewhat contributor or minor contributor to the AgriTech innovation ecosystem?

For HEIs that say they are a critical contributor or a somewhat contributor:

2.2. What are the ways in which University of Nairobi engages with or contributes to AgriTech innovation activities in Kenya?

2.3. You've mentioned a few ways in which University of Nairobi contributes to AgriTech innovation activities in Kenya. What do you see as **the most important contribution** that University of Nairobi has made?

2.4. What are some of the **key factors** that enabled this contribution by University of Nairobi to the AgriTech innovation activities in Kenya?

2.5. In your opinion, in what areas can the University of Nairobi do a better job when it comes to supporting the AgriTech innovation ecosystem in Kenya?

2.6. What are the key barriers preventing University of Nairobi in better supporting AgriTech innovation activities in Kenya?

RQ3: Relationships

3.1. In your view, to what extent does University of Nairobi partner and collaborate with other actors in the AgriTech innovation ecosystem in Kenya?

Probe: if collaboration is not happening, why not, and how can this be improved? If collaboration is strong, which factors contributed to these strong collaborations?

3.1.a. In your view, how important is it for the University of Nairobi to collaborate with other actors in the AgriTech innovation ecosystem in Kenya to achieve its innovation goals? And why?

RQ5: Resources provided by HEIs

5.1. Let's talk about resources. What resources does the University of Nairobi provide to this ecosystem? By resources we mean money, materials, infrastructure, human capital, and any other assets that contribute to the functioning of the innovation ecosystem.

5.2. When you consider the faculty and staff at University of Nairobi, how would you evaluate their capacity and the motivation to engage in the kind of research that can produce innovations related to AgriTech?

5.3. When you consider the graduates from University of Nairobi, how would you evaluate the level and relevance of their skills set to engage in and contribute to the AgriTech ecosystem?

RQ4: Resources needed by HEI

4.1. Let's now talk about resources needed by HEIs. To what extent do higher education institutions have sufficient resources to engage effectively in the AgriTech innovation ecosystem in Kenya? Which resources have enabled engagement and which resources are still needed? By resources we mean financial resources, materials, infrastructure, human capital, or any other asset

Probe into resources related to staffing, infrastructure availability, equipment technology, expertise, intellectual property --- if respondent indicates 'financial resources', ask what the money is needed for

4.2 How adequate are funding mechanisms currently in place to support engagement by your institution in AgriTech innovation activities in Kenya?

RQ8: Policy

8.1. In general, how supportive is the regulatory environment in Kenya when it comes to supporting and promoting the engagement of higher education institutions in AgriTech? Please briefly explain your answer, providing specific examples if possible.

Probe: Can you give examples of specific policies that support HEI engagement in innovation ecosystems and the policies that are a barrier to HEI engagement?

For HEIs that say they are minor contributor:

2.2 Why do you feel University of Nairobi has contributed only minorly to the innovation ecosystem?

Probe: what are the key factors that led to the lack of engagement in the innovation ecosystem?

2.3 How would you describe the level of interest University of Nairobi has in contributing to this innovation ecosystem?

Probe: Why does University of Nairobi have that particular level of interest?

2.4 Can you describe any instances in which University of Nairobi attempted to engage in the AgriTech innovation ecosystem in Kenya but was unable to?

2.5 In what ways do you think University of Nairobi could support the AgriTech innovation ecosystem if it was more actively engaged in it?

RQ3: Relationships

3.1.a. If your HEI were to engage in the innovation ecosystem, how important would it be for the HEI to collaborate with other actors? And why?

RQ5: Resources provided by HEIs

5.2. If you were to engage more in innovation activities, how would you evaluate the capacity of the faculty and staff at University of Nairobi to engage in the kind of research that can produce innovations related to AgriTech?

5.3. When you consider the graduates from University of Nairobi , how would you evaluate the level and relevance of their skills set to engage in and contribute to the AgriTech ecosystem?

Probe: If you were to engage more in innovation activities, how would the level and relevance of graduates' skill sets would need to change?

RQ4: Resources needed by HEI

4.1. If your HEI were to become more engaged in the innovation ecosystem, what resources would your specific HEI need? By resources we mean financial resources, materials, infrastructure, human capital, or any other asset

Probe into resources related to staffing, infrastructure availability, equipment technology, expertise, intellectual property --- if respondent indicates 'financial resources', ask what the money is needed for

4.2. If you were to engage more in innovation activities, how adequate are existing funding mechanisms to support engagement in the AgriTech innovation ecosystem?

Probe: How adequate are internal funding mechanisms? How adequate are external funding mechanisms?

4.3. Beyond resources, what else would be needed for your HEI to become more actively engaged in the innovation ecosystem?

RQ8: Policy

8.1. In general, how supportive is the regulatory environment in (name of country) when it comes to supporting and promoting the engagement of higher education institutions in AgriTech? Please briefly explain your answer, providing specific examples if possible.

Probe: Can you give examples of specific policies that support HEI engagement in innovation ecosystems and the policies that are a barrier to HEI engagement?

ANNEX 3: KII GUIDE WITH NON-HEIs

Key Informant Interviews: Semi-structured Protocol for <u>non-HEI actors</u>

HEIs' Engagement in Innovation Ecosystem, *Kenya*

Interview Date:
Interviewer name:
Respondent name:
Respondent Organization/Affiliation:
Organization type (government, business, CSOs):

A. Introduction

Greetings and thank you for agreeing to participate in this interview. My name is _____. I am a researcher with The University of Nairobi collaborating on a study about the engagement of Higher Education Institutions in the Kenyan Agritech innovation ecosystem.

The purpose of this study is to explore how higher education institutions, across their many forms, can positively influence an innovation ecosystem through a variety of roles while taking into account limiting factors like resources, relationships, and social norms. We are using the term "ecosystem" to describe the set of organizations and individuals that are involved in developing and supporting innovations related to (name of innovation domain) in (name of region). By "innovations," we mean the introduction, development, and operation of new value-added products, services or new and improved processes in the social and economic spheres.

The study is being conducted by the University of Notre Dame, the Resilient Africa Network (RAN), and The University of Nairobi and it is funded by the United States Agency for International Development (USAID).

The purpose of our interview today is to gather information about how specific HEIs are engaging in this ecosystem as well as enablers and barriers that have facilitated or constrained this engagement. You were selected as a possible participant because you were identified as a key actor in the Agritech innovation ecosystem in Kenya, which is the focus of this study

I am recording our conversation so that we can complete our notes for analysis, but the recording will not be shared with members outside of the team assigned to this research. No information which could identify you or your institution will be shared in publications or presentations about this study.

The interview will last approximately 90 minutes. Did you read the consent form? Do you have any questions? [NOTE TO INTERVIEWER: collect signed consent. If any participant refused to grant consent, thank them for their time and advise that they are free to leave].

Ice breaker

Let us start by discussing your involvement in the (name of innovation domain) innovation ecosystem. Could you tell me in what ways have you engaged with or contributed to [innovation domain] innovation activities in [name of region]?

B. Identifying HEIs

As I mentioned in my introduction, we are studying the engagement of Higher Education Institutions (HEIs) in the Agritech innovation ecosystem in Kenya. We are using the term "ecosystem" to describe the set of organizations and individuals that are involved in developing and supporting innovations related to Agritech in Kenya. By "innovations," we mean the introduction, development, and operation of new value-added products, services or new and improved processes in the agriculture sector.

B.1. Which HEIs play a key role in leading or supporting the development and dissemination of [innovation domain] innovations in [region]?

a._____
b. _____
c._____
d._____
e. _____

You have identified these as the main HEIs: *read out the names of HEIs. If the respondent has identified more than five HEIs, ask:* **In your view, which of these HEIs are the most important contributors to the [innovation domain] innovations in [region]? Can you identify the top 5 HEIs?**

We will go through each HEI you have identified and I will ask you some questions about their engagement in [innovation domain] innovations in [region]. *For each HEI listed by respondent under question 1, ask the following questions:*

RQ2: HEI's roles

2.1. Let's start with the University of Nairobi . Would you say University of Nairobi is a critical contributor, a somewhat contributor or minor contributor to the Agritech innovation ecosystem?

Name of HEI	*Rating (critical contributor, somewhat contributor, minor contributor)*

2.2. What are the primary ways in which University of Nairobi **engages with or contributes** to Agritech innovation activities in Kenya?

2.3. What do you see as **the most important contribution** of University of Nairobi when it comes to the Agritech innovation ecosystem in Kenya?

Probe: In your view, what makes this contribution the most important one?

2.4. What are some of the **key factors** that enabled this contribution by University of Nairobi to the Agritech innovation ecosystem in Kenya?

Probe: what made it possible for the HEI to make this contribution?

2.5. In your opinion, in what areas can the University of Nairobi do a better job when it comes to supporting the Agritech innovation ecosystem in Kenya?

2.6. What are the key barriers preventing University of Nairobi in better supporting the Agritech innovation ecosystem in Kenya?

RQ3: Relationships

3.1. In your view, to what extent does University of Nairobi partner and collaborate with other actors in the Agritech innovation ecosystem in Kenya?

Probe: if collaboration is not happening, why not, and how can this be improved? If collaboration is strong, which factors contributed to these strong collaborations?

RQ5: Resources provided by HEI

5.1. Let's talk about resources. What resources does the University of Nairobi provide to this ecosystem? By resources we mean money, materials, infrastructure, human capital, or any other assets that contribute to the functioning of the innovation ecosystem.

5.2. When you consider the faculty and staff at University of Nairobi, how would you evaluate their capacity and the motivation to engage in the kind of research that can produce innovations related to Agritech?

5.3. When you consider the graduates from University of Nairobi, how would you evaluate the level and relevance of their skills set to engage in and contribute to Agritech innovation activities?