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UNIVERSITY LED INNOVATION IN UGANDA:
RESILIENT AFRICA NETWORK (RAN)

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EXECUTIVE SUMMARY

This research focuses on the role Higher Education Institutions (HEIs) play across the entire innovation process, from idea generation to scale. The primary purpose is to understand what HEIs do to support innovation beyond initial idea generation and raising educational levels. Toward this goal, this research presents a case study of the ResilientAfrica Network (RAN), an innovation support and incubation, research, and education program co-located at Makerere University, a HEI in Kampala, Uganda. RAN is an innovation hub and research institute housed within the School of Public Health whose underlying motivation is to bring academics, entrepreneurs, and communities together to address specific development challenges. RAN's specific mission is to strengthen resilience in Africa through university-led local solutions using evidence-based approaches. They support innovators both financially (through grants) and with non-financial means through relevant training, applied co-creation research, technical, business, legal, and regulatory consultancies, as well as other intangible assistance.

RAN was officially established in 2012 as part of USAID's Higher Education Solutions Network (HESN), a network of HEIs around the world who leverage their institutions to tap into emerging innovations, technologies, and approaches for international development. The original intent of HESN was to leverage (1) the emergent trends in creating and testing new solutions for global development; (2) new data tools and techniques; (3) the changing landscape of science and technology targeted to benefit the most vulnerable; and (4) to harness youth worldwide.

The primary data source for this case study is a mixed qualitative and quantitative questionnaire administered to a group of randomly selected *innovations* in RAN's sphere of influence. For each *innovation* selected, *innovators* were asked a series of questions to generate detailed histories of the development process for that innovation, beginning with the initial idea until the innovation's current status at the time of the interview. Interviews traced each innovation's development process, recording major changes made to each prototype, including: the *reason* for each change and the *source of the information* that led to each change. Through these innovation histories, key factors that shaped each development process were identified and variables were coded for analysis.

From this qualitative evidence, the case study presents three principal findings. First, RAN's location at Makerere University enables many innovations to move further along the development process than might otherwise be possible. Specifically, they use formal channels across the university to tap into expertise (moving beyond personal networks) to ensure innovators have access to information.

Second, Makerere University has several internal institutions and processes that RAN leverages. The most important of these is the internal review board (IRB), which provides oversight to innovators during the testing phase of their development process. This oversight both minimizes risks involved with testing and pushes the innovators toward ensuring safety early in the development of their innovations.

Finally, Makerere's reputation lowers obstacles for innovators supported by RAN. As Uganda's premier higher education institution, Makerere University trains, graduates, and is respected by many of the people who staff Uganda's government agencies. As a result, these staff sometimes allow Makerere University oversight processes to substitute for government processes in the short- to medium-term for innovations for which regulations do not yet exist. This has lowered obstacles innovators face during their own innovation's development process. Moreover, it facilitates early conversations with regulatory agencies so government officials are aware of innovations being developed in Uganda that may require regulation in the future. Interviews with ecosystem actors and innovators demonstrate that building capacity of labs operated by government regulators - i.e. the labs responsible for testing the safety of innovations - and regulators will be key for the continued growth of innovation in Uganda.

Taken together, these findings suggest that RAN's status as an institute within a HEI provides additional benefits to the innovators they support. Access to Makerere's expertise and reputation opens doors to innovators supported by RAN, lowering obstacles faced during the development process. While many of these benefits could be built by hubs outside a university context, they are already part of Makerere as Uganda's leading research institution.

Finally, this case study shows that RAN's success is moving beyond its USAID-funded roots. At the time this report is being written, through the work pioneered by RAN, the Ugandan government has committed $16 million in 2019 and 2020 to further support Ugandan research and innovation, a result of the demonstrated importance of local research and innovation as shown through RAN's leadership in this space. Moreover, RAN is diversifying its fundraising outreach to multilateral donors, additional bi-lateral donors, private foundations, and international HEIs looking for strong local Ugandan partners.

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LIST OF ACRONYMS

CDC	Center for Disease Control
EIA	Office of Evaluation and Impact Assessment
ERL	Evaluation, Research, Learning plan
EU	European Union
GBV	Gender-based Violence
HED	Higher Education for Development
HEI	Higher Education Institution
HESN	Higher Education Solutions Network
IRB	Internal Review Board
KII	Key Informant Interview
LAB	Global Development Lab
MoH	Ministry of Health
MFI	Microfinance Institution
MPH	Master of Public Health
NBS	National Bureau of Standards
NGO	Non-Governmental Organization
P5	Primary 5
P7	Primary 7
RAN	ResilientAfrica Network
USAID	United States Agency for International Development

INTRODUCTION

MORGANA WINGARD, USAID

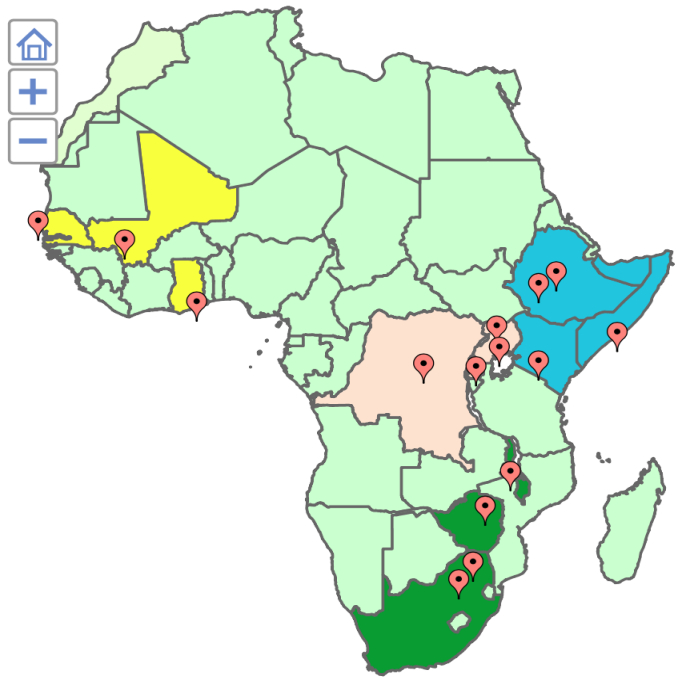
Innovation tends to occur in locations clustered around institutions of higher education (Saxenian 1996; Tan 2006; Youtie and Shapira 2008; Chatterji, Glaeser, and Kerr 2013). Higher education institutions (HEIs) serve as sources of both talent that fuels aggregate innovation as well as unique ideas that spinoff into innovative businesses (Landry, Amara, and Rherrad 2006; Huggins, Johnston, and Steffenson 2008; Bathelt, Kogler, and Munro 2010). Research that examines businesses whose ideas originate within HEIs, however, often has a distinct focus on business development. Studies pay less attention to the role HEIs play in economic development and more toward how incubation programs increase the odds of success for university spinoffs after they "graduate" and become independent businesses (Soetanto and Jack 2016).[1] In doing so, this established research overlooks other important contributions by HEIs. This case study refocuses attention to the role HEIs play across the entire innovation process, from idea generation to scale. Its primary motivation is to understand what HEIs do to support innovation beyond initial idea generation and improvement in educational levels across the workforce.

Towards this goal, this research presents a case study of the ResilientAfrica Network (RAN). RAN is an innovation support and incubation program, as well as a research and education initiative, co-located at Makerere University, an HEI in Kampala, Uganda. RAN is housed within the School of Public Health, whose underlying motivation is to bring academics, entrepreneurs, and communities together to address specific development challenges. RAN's specific mission is to strengthen resilience in Africa through

[1] Consistent with USAID's higher education policy, HEIs are defined as "an organization that provides educational opportunities that build on secondary education, providing learning activities in specialized fields. It aims at learning at a high level of complexity and specialization." Tertiary or higher education is a broader category that includes colleges, universities, vocational, professional education, and affiliated institutes (link).

university-led local solutions using evidence-based approaches. RAN also supports a broad range of innovations toward these ends; however, innovations aimed at solving development challenges in healthcare and agriculture are most common.

FIGURE 1: LOCATION OF RAN LABS



Source: http://www.ranlab.org/rilabs

This map depicts the locations of each RAN-affiliated university. These universities include Makerere University and Gulu University in Uganda; National University of Rwanda in Rwanda; University of Kinshasa in Democratic Republic of Congo; University of Pretoria and the University of Limpopo in South Africa; Lilongwe University in Malawi; University of Zimbabwe in Zimbabwe; Jimma University, Bula Hora University, and Addis Ababa University in Ethiopia; Benadir University in Somalia; University of Development Studies and University of Education, Winneba in Ghana; University of Bamako, Science, Technique and Technology in Mali; and the University of Dakar in Senegal

Many of the development challenges in Uganda already have technical fixes that have worked in other contexts, but these solutions do not get adopted for a variety of cultural, behavioral, political, or other social reasons. As a result, one of RAN supports innovative solutions to development challenges through their incubation hub. This hub teaches innovators how to implement user-centered design to solicit information - including information on the cultural, political, and social context - from end users to feedback into innovations under development.

RAN is headquartered in Uganda but is part of a broader participating network whose members are dispersed across the African continent. The network includes partnerships with over twenty universities in thirteen countries, each of which aims to strengthen the resilience of local

communities by supporting and scaling innovations across Africa. [2]

RAN's support activities are designed to guide innovators through a five-stage, though not necessarily linear, innovation design process: (1) problem definition, (2) ideation, (3) research and development, (4) proof of concept, and (5) implementation and scaling. At the core of the RAN model is a research activity referred to as "needsfinding," which is a form of ethnography. Needsfinding is a fundamental part of human-centered design that uses applied research to understand intended end user preferences and other behavioral responses to a proposed innovation. RAN also connects innovators to experts at the university for consultations and mentorship and provides seed funds to its funded innovators to further develop their innovations. Ultimately, all of this support combines to form an ecosystem of services that include: (1) idea development and refinement, (2) business or organizational development, (3) legal support, (4) the identification and linking of the innovation to other relevant ecosystem actors, (5) facilitating research with end users for further development, and (6) fundraising strategies beyond RAN.

RAN was officially established in 2012 as part of USAID's Higher Education Solutions Network (HESN), a network of HEIs around the world focused on using their institutions to tap into emerging innovations, technologies, and approaches to international development. The original intent of HESN was to leverage (1) the emergent trends in creating and testing new solutions for global development; (2) new data tools and techniques; (3) the changing landscape of science and technology targeted to benefit marginalized populations; and (4) to harness youth worldwide. It now works with a variety of funding partners to continue the goals of understanding and strengthening resilience for communities through research, innovation, and education.

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[2] The network is made up of both regional hubs and "network plus" members, both of which are continuously part of RAN. Regional hubs and network plus members include Makerere University and Gulu University in Uganda; National University of Rwanda in Rwanda; University of Kinshasa in Democratic Republic of Congo; University of Pretoria and the University of Limpopo in South Africa; Lilongwe University in Malawi; University of Zimbabwe in Zimbabwe; Jimma University, Bula Hora University, and Addis Ababa University in Ethiopia; Benadir University in Somalia; University of Development Studies and University of Education, Winneba in Ghana; University of Bamako, Science, Technique and Technology in Mali; and the University of Dakar in Senegal. Each of these universities also partner with additional universities outside this core group on a project-by-project basis pushing the number of total partnerships over twenty.

This case study summarizes research conducted by the U.S. Global Development Lab's (Lab) Office of Evaluation and Impact Assessment (EIA). It originated as part of the Lab's Evaluation, Research, and

Fernando Fidélis, USAID

Learning (ERL) Plan, and its purpose is to generate knowledge from RAN's experiences that may broadly be applicable to other innovation support activities. The overarching goal of this case study is to examine whether universities themselves contribute to the innovation process beyond idea generation and generally increasing the level of education across the workforce (i.e. increasing human capital). To do this, the research focuses on two questions.

1. Which factors at Makerere University have helped RAN innovators perfect and scale their innovations?

2. Which types of innovations are HEIs best positioned to support and why?

With these guiding questions, the case study describes what advantages or disadvantages HEI-based hubs have when supporting innovation. RAN experience, in turn, can inform broader innovation support strategies that USAID may or may not choose to pursue.

THE MAKING OF RAN: THE SCHOOL OF PUBLIC HEALTH

Prior to RAN's official launch as part of HESN, faculty and researchers in Makerere University's School of Public Health had begun to build partnerships with their colleagues at other African universities in Tanzania, Ghana, Ethiopia, and Zimbabwe. In a Key Informant Interview (KII) with a member or RAN's leadership, they stated that the ideas that would eventually feed into the establishment of RAN can be traced back to the 1990s, when schools of public health providing master's in public health (MPH) degrees began to be established in Africa, including at Makerere University.

At the time, most faculty teaching MPH students were trained in clinical research, either in a laboratory or clinical setting. However, it was recognized by faculty of Public Health that new MPH programs and their students would need soft skills in management, public policy, and leadership to be well-rounded public health professionals, soft skills that were beyond the training of most of the faculty. Moreover, Makerere faculty recognized that it would be beneficial for MPH graduates across Africa to "speak the same language" – or rather, have similar training and terminology. Future MPH graduates would need to communicate easily with colleagues in neighboring countries because public health concerns often do not recognize political boundaries.

Makerere faculty knew they lacked capacity in these topics and would need help building these skills. In addition, they knew that they would need to coordinate on some level with colleagues in other countries to ensure public health professionals could communicate across the continent. The idea of a pan-African network of universities, while still informal, emerged during this time. For Makerere, the first step their public health faculty took was to talk to colleagues facing similar issues at other African universities. They began their outreach with Muhimbili University in Tanzania (circa 2000).

Around this time, faculty at Makerere also submitted an unsolicited proposal to Higher Education for Development (HED), an activity funded by USAID, and to the Rockefeller Foundation to build capacity in leadership skills and to speed up the transfer of technology between United States-based universities and themselves. Through HED, Tulane University in the United States partnered with Makerere, jumpstarting this process of capacity building and technology transfer. Next, Johns Hopkins University partnered with Makerere on a project funded by the Center for Disease Control (CDC), providing additional training to Makerere faculty and staff.

By this point, faculty at Makerere had begun to build an understanding of the international donor community. Simultaneously, the concept of resilience had moved to the forefront of international development, discussed often during HED partnership training, so when the HESN call for proposals was released in 2012, faculty and researchers at the Makerere School of Public Health were prepared to create and submit a proposal. Their proposal aimed to formalize a network of higher education institutions across Africa, each focusing on a local aspect of resilience. The work they had done over the prior decade building informal relationships with peer institutions and partnering with U.S.-based higher education institutions, contributed to their success with regards to this competitive award opportunity.

The cooperative agreement with USAID as part of the HESN program allowed faculty at the Makerere School of Public Health to officially launch RAN. The HESN program was key because it allowed Makerere to formalize the network of HEIs they had begun to build over the previous decade. Moreover, RAN could expand the network by leveraging contacts at universities already part of the network to identify and invite additional universities to join, expanding RAN's reach across Africa.

WHAT DOES RAN DO?

As mentioned in the introduction, RAN's support activities are designed to guide innovators through a five-stage, though not necessarily linear, innovation design process: (1) problem definition, (2) ideation, (3) research and development, (4) proof of concept, and (5) implementation and scaling.

In practice, innovations are first put through a diagnostic assessment to determine where they are in this five-stage process, what is needed to generate a minimum viable product, who their intended end users are, and how the innovators will ultimately distribute their innovation to intended end users, as well as assess the strengths of the innovator team. While innovations can enter the RAN program at any of the stages, most enter earlier in the process. To move innovators toward the creation of a minimum viable product – and ultimately, scale – RAN provides six core types of support including: (1) idea development and refinement, (2) business or organizational development, (3) legal support, (4) the identification and linking of the innovation to other relevant ecosystem actors, (5) facilitating research with end users for further development, and (6) fundraising strategies beyond RAN.

Support takes the form of formal trainings, opportunities to present ideas to others for feedback, one-on-one mentorships with RAN staff, linkages to experts at – and outside of – Makerere University, legal

consultations with attorneys, engineering and prototype construction aid, assistance with field research, and introductions to other actors in the ecosystem, from funders to relevant government agencies.

As previously mentioned, at the core of the RAN model is a research activity referred to as "needsfinding," which is a form of ethnography.[3] Needsfinding is applied research conducted with end users to understand their preferences toward a proposed innovation. The innovator brings their innovation to a community where the innovation may address some need or solve some problem, to demonstrate its potential use in the community and gather feedback. For example, an innovation focused on improving post-harvest processing of a crop, would require needsfinding to be done in a community with many farmers who grow that specific crop.

Needsfinding is the foundation upon which RAN's approach to innovation support is built. In an interview with a member of RAN's leadership, they stated that incorporating needsfinding in the development process for each innovator is "followed quite religiously." In a separate interview with a different member of RAN leadership, they also stressed the importance of needsfinding. In their view, a pivotal moment in RAN's organization development occurred when RAN was able to finalize a process for innovators to follow for needsfinding, which built upon and adapted ideas from initial partners at Stanford University's Change Labs. This occurred when RAN finalized their resilience framework and identified local communities in Uganda who faced problems consistent with the framework. RAN entered MOUs with these local communities (via the appropriate level of local government), reducing bureaucratic obstacles that would hinder individual innovators from conducting needsfinding, making it easier for their innovators to implement this important step in their innovation processes.

Needsfinding has been part of RAN's support model since its inception. When RAN opened its doors, its founders saw that many issues facing Uganda were multidimensional in nature. As a result, solutions developed at RAN would require an interdisciplinary approach in order to achieve success. Many of the development challenges in Uganda already have technical fixes that have worked in other contexts. For example, improved post-harvesting processes have been adopted elsewhere in the world, and medical

[3] Ethnography is a qualitative research method that observes people in their own environment, often using participant observation and face-to-face interviews to generate detailed descriptions of customs and behaviors.

devices have already improved the quality of healthcare in other locales. However, these solutions have often not been implemented due to cultural, behavioral, political, or other social reasons, preventing their use in Uganda. RAN's founders surmised that to get innovations adopted, they would have to be adapted to local end users. In their thinking, this required an innovation component because many solutions developed at RAN would, by necessity, be different than solutions adopted elsewhere. As a result, RAN's innovation support activities would also require a research arm to test the preferences and behavioral responses of end- users to each proposed solution.

RAN also connects innovators to experts in the university for consultations and mentorship. During a KII with a member of RAN leadership, they said they thought this was enabled by Makerere University's administration shift in policies toward incentivizing interdisciplinary research by faculty around the same time RAN incorporated. This has made RAN an attractive partner to scholars in the School of Public Health and elsewhere at Makerere University. RAN staff are drawn from multiple disciplines that include engineering, information technology, and public health so while RAN staff have varied and diverse skills, their skill mix is not exhaustive and can be augmented with others on campus.

Here, RAN's formal relationship with Makerere comes into play. When they have needed technical knowledge beyond what their staff can provide, they formally contact the principal of the university department or college they need expertise from (i.e. the Dean or other high-level administrator) to get permission to solicit assistance from faculty in that department. Sometimes they know who they would like to get assistance from and directly request to be put in touch with that person, but other times they will request the principal to match RAN with the appropriate faculty member. As a result, RAN has well utilized the network of experts at Makerere and has tried to ensure their innovators have access to the relevant expertise when they need it.

RAN also provides seed funds to a subset of its innovators. To do this, they use three channels to select the innovations they support (1) an innovation acceleration program where RAN holds exhibitions to identify promising ideas for funding, (2) innovation grand challenges through open calls, and (3) collaborative innovation design where innovators are brought together to co-create a single platform

that provides several solutions.[4] In addition to providing funding, RAN also supports innovators through several different forms of innovation showcase and feedback events. Examples include *Pitch Tuesdays* where an innovator presents an idea (the gap to be filled and the proposed solution) that they have identified and receives feedback, *Innovation Fireplaces* where more established innovators showcase their work and connect with other innovators and interested parties, and *Innovation Garages* where group discussions are held about larger challenges or solutions. Each of these innovation support activity types are tailored to meet specific needs.

RAN also schedules specific innovators to present their idea when a topical expert is able to attend to ask probing questions about the identified problem and its solution, as well as to provide general feedback. When RAN's own staff cannot fill this role, they arrange for the appropriate Makerere faculty or non-faculty experts to attend such events. *Pitch Tuesdays* are open to the public; anyone can go to the RAN website to sign-up. Through this channel, select innovations are identified for additional support, whether financial or otherwise.

RAN has also created additional channels for supporting innovators' access to funding. For example, RAN has held matchmaking events to connect innovators to potential investors. At these events, an innovator may have an idea that addresses an issue related to post-harvest processing, for example, but has had difficulty identifying a market strategy that would help them scale their innovation. In these cases, RAN might hold an event calling for innovators to promote their solutions to the investors. In these cases, the initial innovator may be identified through the selection methods discussed above, while a second partner is identified through a specific event.

Finally, RAN noticed that female participation in innovation activities was low. To address this, they built inclusive outreach activities into the RAN award to establish the RAN4Gals program which targets girls and women in secondary schools and colleges aimed at confidence building, capacity building, and innovation activities. Through these efforts, they also identify and select female innovators to join RAN's larger innovation activities.

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[4] Current thematic opportunities found at: https://grants.ranlab.org/

Irene Angwenyi, USAID/Kenya

PREVIOUS RESEARCH AND ITS APPLICATION TO RAN

Previous research has put forth several explanations for why innovation tends to occur in geographically compact spaces – or clusters – with two patterns emerging from this literature. First, information is a key ingredient for innovation and close geographic proximity enables it to easily flow between innovators and others in the cluster (see Chatterji, Glaeser, and Kerr 2013 for an overview). Second, successful clusters generally include the presence of a HEI (Saxenian 1996; Tan 2006; Youtie and Shapira 2008; Chatterji, Glaeser, and Kerr 2013). Further, two broad sets of explanations for clustering around HEIs have emerged in this literature. Specifically:

(a) Formal Economic Explanations - a reduction in costs, which produces economic benefits and information flows that increase innovation; and

(b) Informal Relationships and Reputations – informal relationships lead to a shared language among cluster actors, often replace formal market structures, and ultimately an increase in innovation.

Within both explanations, HEIs reside in the background, serving as a source of ideas and an educated workforce. This case study's purpose is to bring the role of the HEI to the forefront. While clusters generally include HEIs, it remains unclear what exact role they play. Does their presence simply increase the aggregate level of education in the workforce, some of whom innovate? Or do HEIs provide specific expertise to innovators to solve discrete obstacles? The former would suggest simply funding innovation hubs near ***colleges and universities*** is enough to unlock these benefits, while the latter suggests ***HEIs*** provide specialized expertise. Expertise that may be more easily accessed through a formal relationship between the HEI and the incubation hub.

FORMAL ECONOMIC EXPLANATIONS

Explanations in this group suggest that proximity simply reduces various types of transaction costs between suppliers, innovators, topical experts, and/or end users. Reduced transaction costs take three forms. First, reduced transaction costs lead to more economic transactions overall, increasing the frequency of interactions between innovator and end user. More interactions allow for information about end user preferences to be fed back into the innovation itself (Chatterji, Glaeser, and Kerr 2013).

Second, lower transaction costs between firms leads to economies of scale for input suppliers and service providers (Tracey and Clark 2003). As the number of customers (i.e. innovators) grows for suppliers, the per unit price within the cluster drops, enabling innovators to buy more inputs with fewer funds. Lower per unit costs attract additional innovators to the cluster and the diversity of buyers for suppliers stabilizes supply chains for innovators.

Third, clustering further decreases labor mobility costs, that is, it is easier for skilled workers to move from job to job and firm to firm, increasing information flows. When they do this, they take what they learned from their previous work to their new setting. This channel was identified from the experience in Silicon Valley, which saw workers move from firm to firm to work on different projects, taking knowledge accumulated through experience with them to apply at their new firms (Saxenian 1996).

While these three factors may lead to an increase in aggregate levels of innovation, they may not yet apply to the geographic context of Kampala, nor to RAN. The third explanation, where labor mobility

drives information flows, requires that formal firms exist so that local labor can sort itself into its optimal configuration. Evidence presented below will demonstrate that a predominance of formal firms describes very few of the innovations RAN supports or the larger innovation space in Kampala. The second explanation, where suppliers in the cluster reach economies of scale driving down input costs, requires innovators to be working in related technical areas, all of which use similar inputs. However, this case study will demonstrate that RAN-supported innovations span healthcare, agriculture, and other relevant areas that use a wide variety of inputs and approaches. For the first explanation, it is true that RAN has become quite adept at ensuring their innovators solicit information from end users, but the channel through which this takes place is not yet accomplished by increasing the number of market transactions that take place.

To summarize, RAN and the innovation cluster in Kampala more broadly, is not (yet) accurately described by this perspective which is rooted in the experience of Silicon Valley. A second group of explanations, however, based on informal relationships and a shared language, may more accurately describe the RAN experience and serve as a useful departure point for this case study.

INFORMAL RELATIONSHIPS AND REPUTATIONS

The second set of explanations focus on the informal nature of innovation clusters. Although innovation can occur within long established firms, especially to fend off new entrants and to maintain market share, much innovation is driven by individuals operating small, unincorporated firms. Rather than fending off competitors, these innovators develop new ideas to reach new markets or end users. Explanations of this type narrow in on this informal space to explain how geographic proximity ensures innovation thrives. The basic argument is that regular interactions between innovators and other actors in a cluster allow everyone to gather information about each other, allowing innovators to build local reputations within the cluster, especially those actors who might do business together in the future. *Trust* and *knowledge* are essential as they substitute for these formal processes, allowing for contract enforcement to be assured (Blomqvist and Levy 2006; Tracey and Clark 2003). Further, this perspective argues that 'shared language' between cluster actors is key because it enables information to flow across the cluster, a necessary condition for *knowledge* of others to be built (and as a result, *trust* to be established and *reputations* to be formed).

While this perspective may not perfectly describe RAN and the innovators it supports, it is more in tune with the RAN experience. To preview findings from the qualitative survey of innovators for this case study, it was found that: (1) innovators work on their innovations informally or as very small firms, both

of which are too small for labor mobility to play a role, and (2) each actor's knowledge of other actors, specifically of their reputations, plays a role in overcoming obstacles faced by RAN innovators. RAN's motivation and stated objective "to strengthen resilience in Africa through university-led local innovative solutions using evidenced-based approaches" seeks to find specific answers to unanswered development challenges. RAN provides support to new ideas and actors, not established firms, making their approach more consistent with informal innovation clusters.[5] As a result, the perspective on informal innovation clusters provides a useful departure point and a lens through which to examine the RAN case.

HOW HEI'S IMPACT INNOVATION: GENERATING HYPOTHESES

Karen Kasmauski, USAID

The literature cited in the previous section highlighted two broad factors that may affect innovations incubated by RAN: the spread of information (and its sources) and reputation (an outgrowth of one's knowledge of others in the cluster). RAN is organized into four regions, with one prime institution in each region (see map in Introduction Section). These four universities were selected based on their individual capacities and their ability to influence other universities within their regions. The network is decentralized, each prime university receiving their own funding to administer across their respective region. While the network includes multiple universities across Africa, these two broad factors can be examined by focusing on one such university cluster because each is specific to a single geographic location. For this case study, the research focuses on RAN's flagship hub at Makerere University in Kampala, Uganda. The case study's principal question is: how does RAN's location within a HEI condition RAN's innovation support? Put differently, how do HEI-specific factors alter the innovation process for innovators?

[5] http://www.ranlab.org/about-us/strategic-direction

An important aspect of information exchanges between actors in a cluster is the ability for innovators to incorporate end user preferences into the innovation design. This aspect is included in both perspectives, outlined above, covered in the literature. While both formal and informal perspectives assume that this is a naturally occurring process that happens through (mostly) business transactions, RAN builds into all of their innovation support work the expectation that the innovator will work constructively, collaboratively, and regularly with their intended end users through the needsfinding process. This process seeks to provide the innovator with feedback by eliciting information from their intended end users at every stage in the development process. Information sought through research and university regulations means that this work naturally takes on a more formal process. As a university-based hub, RAN innovators must go through the proper channels to ensure end users, human subjects from the university's perspective, are protected. This practice has several potential implications.

First, it establishes, ensures, and formalizes the flow of information between innovator and end users early in the development process. Research with human subjects must be approved by Makerere's Institutional Review Board (IRB), whose purpose is to ensure that research follows ethical standards and does not put participants at risk by taking part in the research. At a minimum, there is an application and review process that requires the researchers (innovators in this case) to explain how they will reduce risks faced by the human subjects for providing information to the innovator. As a result, formal questionnaires, research protocols, and safety precautions are incorporated into the innovation's design from the beginning and certainly before a minimum viable product is developed. This formal process may slow the initial development trajectory as these additional bureaucratic hurdles (IRB, etc.) must now be cleared.

Second, most innovations will have met regulatory requirements before they can scale their innovations broadly. Time lost to the IRB review process early on may be made up later as innovators are forced to address safety concerns as they develop their innovations. The IRB process forces innovators to think through safety concerns, ***and address them***, prior to approaching the relevant regulating authority in the Ugandan government. This could speed up the future process of the innovation from minimum viable product to scale.

Third, a different type of information exchange may also be present at RAN that is unique to HEIs. Recall that HEIs strive for "learning at a high level of complexity and specialization,"[6] which often means a focus on research and innovative methods, in particular, this focus is specific to a university, as opposed to other types of HEIs. As a result, HEIs employ highly specialized faculty and other researchers across various institutes, laboratories, colleges, and departments who can provide not only highly technical information to innovators, but also advise them on strategies for testing those ideas.

And fourth, the last form of information that HEI's may provide are reputational benefits. The academic literature highlights that informal relationships can impact innovation via *knowledge* and *trust* of these actors in the cluster; through these interactions, actors know with whom they can make informal agreements with less risk. Actors in the cluster will have interacted with Makerere as students, professionals, and via their personal networks. Most will have knowledge of Makerere, and many will have developed trust towards it as an institution itself, prior to learning of an innovation or meeting its innovator. Innovators supported by well-known institutions, such as Makerere University, gain reputational assets through their association, signaling to other actors in the cluster their innovation is a serious idea that has already been vetted by knowledgeable and trusted experts. In essence, Makerere University's reputation "rubs off" on the innovators they support. Reputational benefits may manifest themselves between innovators, an innovator and an investor, an innovator and a supplier, as well as numerous other possible partners. Looking at this case study's information flow allows us to focus not only on whether this information and trust exchange is occurring, but also to hypothesize ***how*** reputational benefits pass to innovators supported by RAN.

With these broad research ideas outlined, the rest of the case study explains how the data was collected, presents qualitative evidence, and finally, presents an analysis of the four factors and hypotheses outlined here.

[6] Per USAID's definition of HEIs outlined in footnote 1.

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DATA COLLECTION: BOUNDARIES AND SAMPLE SELECTION

Defining the boundaries of an innovation cluster is inherently subjective. While scholars agree that close geographic proximity defines a cluster, the word "close" is open to interpretation. Since its inception, RAN has collected information on each of the innovations and innovators who have participated in any event organized by RAN. Here, 'participation' includes receiving a grant from RAN, using their office space, pitching an idea to them (whether the idea was funded or not), attending an innovation event supported by RAN, or having taken part in one or more of RAN's free training courses or workshops. RAN tracks these innovators using two separate lists:[7] one includes those directly funded with awards (i.e. core or funded innovators), and the second captures those who have participated in RAN activities, but who have not received funds from RAN (i.e. non-funded innovators). The list of funded innovators includes all funded projects dating back to 2015, and the list of non-funded innovators includes innovations from events that pre-date 2015.[8] In the case of RAN, innovators who receive

[7] The fact that there are two lists reflects the fact that innovators who have received awards provide substantially more information to RAN as they are entered into a financial award, while the second list is generated to know what innovations exist and may need assistance. For this latter group, RAN only keeps minimal information.
[8] Events include Pitch Tuesdays at RAN, Technovation 2017, Technovation 2015, Innovation Garage, HiiL, TechCon 2016, TechCon 2014, GIS Hackathon, UDB-iGrowth, Transport Hack, EVAWG Bootcamp.

formal monetary support from RAN are directly connected and therefore within the first order and strongest level of "closeness." Looking beyond these core, funded innovators, however, it becomes more subjective as to which innovations RAN's activities plausibly help (or hurt). As a result, it is less clear whom to include in the universe of this study. RAN's non-funded innovations, while not as strongly or directly tied to RAN, still receive many of their non-monetary services, communications, tools, and resources.

This study takes a pragmatic approach. It defines any innovator who has participated in a RAN sponsored or co-sponsored event to be a part of the cluster. This means the set from which to draw the study sample includes funded innovators, as well as all participating non-funded innovators. Importantly, this includes innovators who have had only brief, limited contact with RAN over the past five years. Using this sampling universe to randomly select respondents generates a sample broadly representative of the RAN cluster as has been defined here. The inclusion of non-funded innovators is essential in order to be able to investigate the broader information flows, as described in the literature. Non-funded innovators often have access to information within the cluster, as is true within RAN, even if they are not formally funded, which would be missed if the study interviewed solely funded innovators. Moreover, while this sample is not representative of Kampala's entire innovation landscape, as it does not include innovators who work with other private or not-for-profit hubs elsewhere, it does represent a larger sub-population than just those innovations RAN finances.[9]

The primary data source for this case study is a mixed qualitative and quantitative questionnaire administered to a group of randomly selected *innovations* (not innovators). For each *innovation* selected, *innovators* were asked a series of survey questions to generate detailed histories of the development process for that innovation, beginning with the initial idea until the innovation's current status at the time of the interview. Interviews traced each innovation's development process, recording major changes made to each prototype, including: the *reason* for each change and the *source of the information* that led to each change. Through these innovation histories, key factors that shaped each development

[9] Recall, a UNHCR study identified 10 innovations hubs in Kampala.

process were identified and variables were coded for analysis. Importantly, this questionnaire format allows the survey to generate data that captures the *temporal process* for each innovation.

Although each innovation differs with respect to individual details, they follow a broadly similar trajectory over time - the so-called innovation development pathway described earlier. In this pathway, each innovation begins as an idea that is developed into a prototype. The first prototype serves as a "rough draft" that improves over time with the creation of additional prototypes, each improving on its predecessor. Several iterations of the prototype may be created before it is ready for testing and feedback from its end users. Many innovators will loop back and forth through this process with refinements and learnings dictating its often non-linear journey. Ultimately, a well-tested prototype will be scaled to reach its intended end users.

At some point in this process, the innovator must start thinking about which distribution channels are available, or can be built, to ensure the innovation gets to its intended end users. The innovator must shift their focus from prototype development to market analysis (or to their chosen distribution channel, if not market-based). With this shift in focus, a different set of skills is often needed. Developing the innovation may require scientific or other technical knowledge, while developing a distribution strategy may require business and/or other organizational skills.[10] While this is an oversimplification of the innovation process, it highlights that research on incubation support activities provided by RAN must capture both (1) the technical prototype development and improvement stage of the innovation process and (2) the stage where distribution channels are identified and developed *over time*.

The questionnaire also asks about the current state of innovation, information about the innovator, and other information current at the time of the interview. Since respondents are chosen randomly from the two lists of innovators kept by RAN, these questions provide a *representative cross-section* of

[10] Soetanto and Jack (2016) call these two phases "technology" and [market] "exploitation" to draw a distinction between the development of the innovation, which is rooted in research at the University, and strategies for business development and scaling based on knowledge of market needs. Similarly, Voss and Voss (2013) distinguish between product and market-oriented learning for innovative firms.

innovations at a single point in time. Therefore, this case study can describe the RAN cluster for comparison to other clusters in the broader literature.

Further, this research incorporated a snowball component for a subset of respondents to identify individuals for KIIs). Specifically, a small subset of innovators who had received help from other actors in the cluster were asked to provide contact information for those individuals who had helped them with some aspect of their innovation process. KIIs were conducted to gain insight into what kind of information was being used by innovators from other actors in the cluster and to identify who these individuals were.

Finally, RAN staff introduced the researchers to individuals in select Government of Uganda Ministries whose responsibilities include encouraging and/or regulating innovation. These interviews were conducted after innovators identified government actors as part of their innovation processes. Information from these interviews was not systematically collected, however, and will only be used for illustrative purposes throughout the text. Six interviews were completed through the snowball information gathering method, each interview with a person who had provided expertise or feedback to an innovator on their innovation at some point in their process, and four interviews were conducted with government officials.

The survey instrument included both open-ended qualitative questions and close-ended quantitative questions.[11] Interviews took place over two trips to Kampala in April 2019 and July 2019. Quantitative questions allow the analyst to perform some basic statistical tests, while qualitative questions were used to capture the details of the innovation process over time from the respondents. The primary analysis focused on the qualitative data generated from the semi-structured innovation histories, but quantitative data are also presented for descriptive purposes. Moreover, each innovation is coded into its technical area, so the reader gets a general idea of what types of innovations RAN supports. Finally, the *number* of changes made to the innovation during each innovation's development pathway process is presented to give the reader an idea of how many steps innovators must make to get their innovations to end

[11] Makerere School of Social Sciences IRB Number MAK REC 01.19.253 (approved March 13, 2019) and Social Solutions International IRB Study #51 (approved March 20, 2019).

users; a measure conceptually consistent with a measure often found in the economics literature (Campos et al. 2017).[12]

Despite the availability of select quantitative measures, the heart of this case study and analysis is the qualitative evidence generated from the innovation histories in the survey. Respondents were first asked to describe their innovation in detail as it currently stands, then to describe their original idea, and finally to describe in detail each prototype they created. They were also asked to explain how it was different from the previous prototype (or the original idea if it was their first prototype), why they made that change, and who they discussed that change with before deciding to make it. Once they described this process in detail, the interviewer counted the number of changes made and verbally confirmed this number with the respondent to generate a measure that captured the number of iterations the innovation had undergone.

The key methodological difficulty with this case study is finding a way to analyze how RAN's relationship with Makerere University shapes its innovation support work because the HEI is a fixed entity: its existence has remained constant throughout RAN's existence. Given this, the research must identify some set of factors within the university that can shape the innovation processes uniquely (vary) across innovations. Two possible solutions come to mind.

First, one might simply move down a level in the university structure, analyzing how each department or college within the University works with (or does not work with) RAN innovators as they develop and scale individual innovations. Alternatively, the case study may group similar innovations into categories to analyze how different innovation categories engage with actors across the University. The former approach leverages variation within individual colleges or departments, while the latter leverages variation within the population of RAN innovations.

This case study chooses the latter approach for two reasons. First, RAN has little control over departments and colleges outside the School of Public Health, where they are located. While they have

[12] Other common measures such as patents would produce non-representative results in Uganda. Moreover, government data on innovations, as has been collected by the Small Business Administration in the USA (e.g. as used in Acs and Audretsch 1988), do not exist yet in Uganda.

worked hard over the years to develop productive relationships across the University, those relationships exist outside their formal line of authority. They do, however, have control over which innovations they support and what support they recommend or provide to those innovations. Therefore, findings generated from this source of variation could be incorporated back into their programming, if applicable.

Second, the purpose of the activity is to develop and scale solutions to development challenges in Uganda and across Africa. Therefore, the success or failure of the individual innovations is the ultimate targeted outcome of RAN's work. If RAN proves to be better equipped to identify and support one type of development challenge, when compared to a different type, then this information is potentially actionable. For example, they could either shift resources toward those types of challenges or seek out new expertise (i.e. staff) to help them fill any gaps identified.

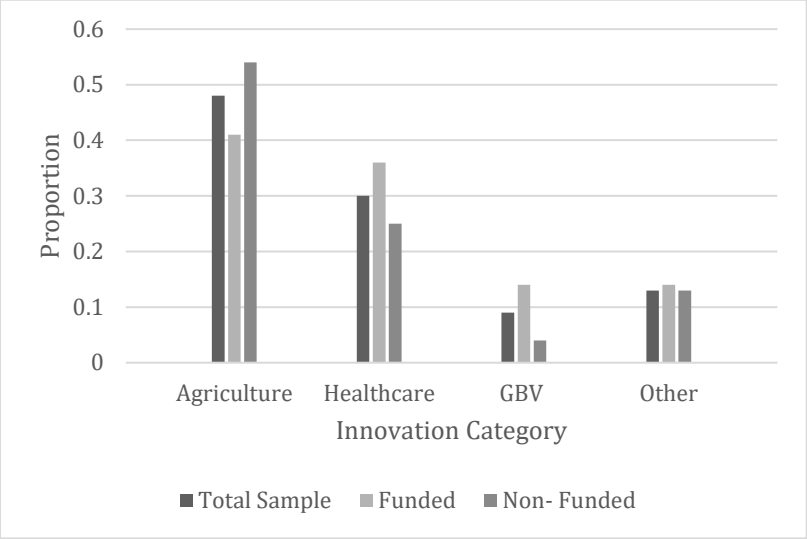
The principal "independent variable" in this analysis then is the innovation's sector – formally coded as a typology – including agriculture, health, gender-based violence (GBV), and a miscellaneous category called "other" for those innovations that do not fit into the first three categories. The analysis here focuses principally on health and agriculture as they make up the bulk of the innovations. By focusing the analysis across these sectors, one can examine how different types of innovations are helped, or hindered, by their association with RAN, and Makerere University more broadly.

WHO DOES RAN SUPPORT?

Figure 2 presents the proportion of RAN innovations by sector and gives a general idea of the distribution of innovations present across the entire cluster. Agricultural innovations make up about half of the cluster, healthcare innovations about a third, and smaller percentages for GBV and the Other categories. In Figure 2, the data are also broken into funded and non-funded innovations to see whether there are differences between the types of innovations RAN supports financially versus those it does not. While we can see that the sample includes funded healthcare innovations at a higher percentage than exist in the sample generally, the difference of proportion tests show this difference is not

statistically significant compared to non-funded healthcare innovations (See Annex, Table 1).[13] Similarly, the sample includes fewer agricultural innovations on the whole than exist in the sample, but again, this difference is not statistically significant (ibid). For GBV innovations, approximately 4 percent of innovations in the non-funded list fit into this category. And finally, the Other category is approximately 13-14 percent of both the funded and non-funded categories.

FIGURE 2: PROPORTION OF INNOVATIONS BY CATEGORY



This graph depicts the proportion of each innovation category: agricultural innovations, healthcare innovations, GBV innovations, and other miscellaneous innovations. Within each category, the darkest bars (left) include both funded and non-funded innovations, the lightest bar (middle) includes only the funded innovations, and the middle-shaded bar (right) includes only the non-funded innovations.

The prevalence of GBV innovations in the sample was explained during a KII with a member of RAN. UN Women funded an open call specifically for innovations that address GBV issues which at least partially explains the high rate for this type of innovation. For healthcare innovations, the data is too limited for an analysis to determine the reason for the prevalence of these innovations, but several possible reasons may explain this pattern. For example, one possibility is that – on average – innovators developing healthcare innovations require more education and human capital before they can both identify and propose an

[13] Table 2 in the Annex uses difference of proportion tests to roughly gauge whether a difference can be detected across funded and non-funded innovations. This provides a rough idea of whether funded innovations reflect the cluster more broadly or whether RAN supports financially certain types of innovations more/less relative to the broader set of innovations in the cluster. Specifically, t-statistics are calculated because in finite samples, such the one used here, the t-distribution makes adjustments that limit the likelihood of Type I error compared to the normal distribution.

innovative solution for the health sector. If that is true, then innovations proposals might be of higher quality than other innovation types, and RAN's funding of them at higher rates is simply a reflection of this reality. Alternatively, innovators may sort themselves prior to applying to RAN. Since RAN is affiliated with the School of Public Health, it is possible that innovators in the healthcare space first pitch to RAN as it is believed that their professional network in this space is broader, compared to other acceleration hubs. Along the same lines, non-healthcare focused innovators may first pitch their ideas elsewhere if other hubs have reputations within a specific sector. While the data here are unable to confirm or disconfirm these possibilities, the patterns in Figure 2 highlight an area of inquiry for future research.

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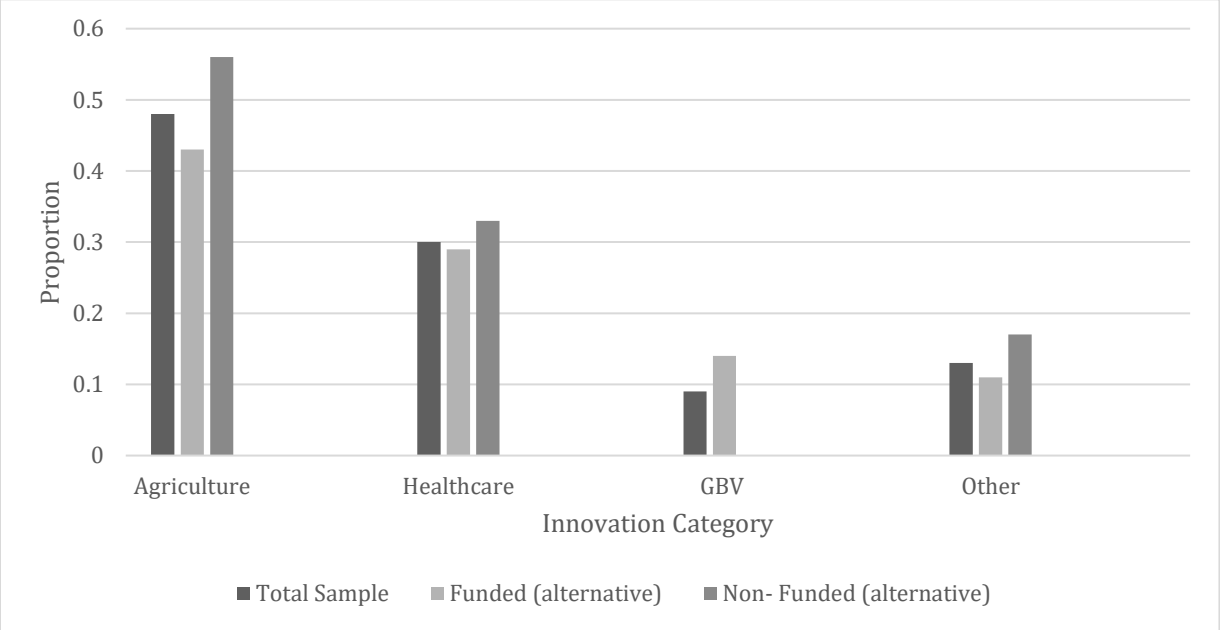
Next, the analysis digs a bit deeper into the overall distribution of innovations in the RAN cluster. Recall that respondents for the survey were drawn from two lists: a list of funded innovators and a list of non-funded innovators. Since RAN makes subawards over time, the non-funded innovator list serves as a pool to which RAN disseminates funding opportunities and other ecosystem events as they become available. Consistent with this logic, there were a small number of innovators who were on both the funded and non-funded list, on the non-funded list initially, but who received funding from RAN at some later point in time. This is possible because their first contact with RAN was at a RAN

event, workshop, or activity, entering them into the RAN ecosystem and getting them onto the non-funded list, yet at some point after that initial contact, they applied for and were selected for funding. Shifts from the non-funded to funded list provides some additional descriptive evidence about RAN's funding trends over time and a slightly different snapshot of the cluster. Figure 3 presents the same data as Figure 2, but re-codes six innovations who were non-funded at first but received funds at some later point in time.

FIGURE 3: PROPORTION OF INNOVATIONS BY CATEGORY (ALT. DEFINITION)



This graph depicts the proportion of each innovation category: agricultural innovations, healthcare innovations, GBV innovations, and other miscellaneous innovations. However, it re-codes six innovations who were non-funded at first but received funds at some later point in time. Within each category, the darkest bars (left) include both funded and non-funded innovations, the lightest bar (middle) includes only the funded innovations, and the middle-shaded bar (right) includes only the non-funded innovations.

Figure 3 demonstrates that ultimately RAN funded all of the GBV innovations over time within this sample, and as a result the difference between funded and non-funded groups is statistically significant,

despite small samples (see Annex, Table 3).[14] This suggests that while there are few GBV innovations in Uganda, by the time of the survey RAN funded all those that they had identified. Recall, UN Women

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funded a specific open innovation call to address GBV through RAN, likely explaining this shift. However, because RAN funded every GBV innovation in the sample, it suggests that the supply of this innovation type lags donors' desire to fund GBV innovations. This is of course not reflective of RAN specifically, but of a mismatch between supply and demand to find solutions to GBV in Uganda more broadly.

[14] See footnote 6. Table 2 is constructed by the same logic as Table 2 in the Annex.

SELECTED INNOVATIONS REPRESENTATIVE OF RAN SUPPORT

To understand the role that Makerere University generally plays on an innovation's path from minimum viable product to scale, we examined innovation histories, grouped by innovation types. The primary focus of the analysis is on differences between health and agricultural innovations as they are the two largest sectors represented in the cluster and provide the potential for clear contrasts. GBV innovations will also be discussed.

In particular, the potential for three contrasts stand out. First, the type of information needed by healthcare innovators may differ from those in the agricultural sector. As a result, the university experts that innovators access at Makerere, and the departments they engage, with will likely be different. Second, given RAN's focus on needsfinding, healthcare innovations may require applied research with patients and more oversight than agricultural innovations which will often be geared toward working with crops instead of people. Third, the path to scale in the two sectors will likely be different. A healthcare innovation may need to be adopted by a government clinic to reach scale, while a machine addressing post-harvest handling may be sold directly to farmers themselves. One path to scale is via private markets, while the other is sales to a public entity.

This section presents short case studies that exemplify innovations in each category. It begins by presenting representative examples of agricultural innovations, the most common type of innovation in the RAN cluster. Each case pays particular attention to and highlights (at least) one of the three dimensions outlined above. The cases will identify the various obstacles faced by innovators in Uganda in the innovation histories and describe how innovators have addressed these obstacles. Patterns found across innovation types will then be discussed.

AGRICULTURAL INNOVATIONS

MUSHROOMS: RECYCLING WASTE

Jyoti Sangh, USAID

RAN funds an innovator whose aim is to increase mushroom cultivation in Northern Uganda to diversify crops and increase food security. They collect corn husks from farmers post-harvest, and rather than burning the husks, the innovator uses this organic waste stream to make a substrate that can be used for growing mushrooms. Once the substrate is finished growing mushrooms, the remains can be reapplied to the soil as fertilizer. This innovation has the potential to reduce negative externalities associated with burning crop waste, while also providing an additional source of income to farmers who use it. Moreover, the vertical nature of mushroom farming means little land is needed to generate these benefits.

This innovator's development process was still ongoing at the time of the interview; however, they had created a basic system for cultivating mushrooms from recycled waste and iterated their innovation several times. They had initially designed a manual method, but further iterations led to the fabrication of a machine to sterilize inputs to form the needed substrate. Further, they fabricated a second machine to chop the waste more efficiently. Both changes were made to make the manual method more efficient so that they could increase production.

Once these two machines were fabricated, they changed the way they sterilized inputs. Initially, they used heat, produced by burning firewood, but now they use specialized chemicals to increase efficiency. The innovator decided on this change after searching for better methods on YouTube. The innovator has since considered testing the use of a solar dryer after having seen one used by another RAN innovator because it would be more environmentally friendly, but they had not procured one at

the time of the interview. The innovator was also experimenting with a process they called the 'indigenous microorganism method' to help crush maize cobs, an idea they picked up from visiting international researchers they met at an event at Makerere University.

This innovator received funds from RAN, as well as training on how to register a company. At the time of the interview, they had a legally registered company as a result, not particularly common in Uganda where the informal economy dominates the sector. RAN also connected them to farmers who want to buy spores and substrate and learn their process, so RAN has helped the innovator identify customers too. Finally, RAN helped the innovator with needsfinding in the north of Uganda to introduce mushroom cultivation there.

For this innovator, the development of their innovation did not require the expertise of topical experts at Makerere, as they made changes themselves from information they actively sought out (for example via YouTube). Yet their connection with Makerere did lead to them having a conversation with international agricultural experts that led to the innovator's search for a more efficient process. Although RAN helped facilitate their needsfinding and funded it, this innovator did not identify any changes made to their innovation for further refinement due to needsfinding. Despite this, RAN's facilitation of needsfinding led to the identification of potential customers. While it is possible the innovator may have identified customers without RAN's support, needsfinding contributed directly toward this.

Nonetheless, this innovator made five distinct changes during their process and incorporated information from others via RAN (other innovators) and via Makerere (via international researchers). There is evidence of information exchanged within the cluster leading to experimentation with the innovation, but they also searched the internet for information to improve their innovation.

FORTIFIED PORRIDGE

RAN also supports an innovator who sources local agricultural produce to be processed, packaged, and fortified with nutrients to increase the intake of nutrients (including protein, minerals, and certain vitamins) by poor Ugandans. This innovator's motivation for developing the product is to improve the nutritional intake of pregnant and lactating mothers, but their hope is to eventually sell their product more widely, to all groups across Uganda. Their primary product is a porridge made of various cereals and legumes that includes a wider array of cereals than in porridge commonly found in local markets. The legumes provide protein and the innovator adds a supplement so the porridge includes

nutrients beyond those they can source locally. In particular, the porridge includes zinc and iron – two minerals missing from most products found in Uganda. The fortified supplement is imported from a company in Europe.

This innovator is a nutritionist by training, and when they created the first version of the product, they focused on getting the balance of ingredients right to ensure mothers received the nutrients they needed. RAN supported their needsfinding, which focused mostly on whether end users liked the taste of the product. Feedback they got during needsfinding led them to change the mix of ingredients. Specifically, some end users did not like the original taste so new ingredients were added to change the flavor profile.

For this innovation, product development was quite straightforward and was akin to the innovator experimenting with recipes in their kitchen, only with the added step of needsfinding to test the product and gain information about the preferences of the end user. However, since this is a food product that will ultimately be sold in Ugandan markets and shops for people to consume, production requires a sanitary process. Specifically, the process will have to meet safety standards set by the National Bureau of Standards (NBS). However, the innovator, a nutritionist, did not have this knowledge or expertise. They did not know how to produce large quantities of foodstuffs ***safely*** in a factory setting. As a result, their innovation process shifted focus from product development to the question of how to scale.

The innovator was connected to a researcher in the Department of Food Science at Makerere University by RAN to help identify specific issues related to food safety. From this mentor, they learned several things. First, they learned that storing large volumes of grain increased the risk of certain toxins being present in the final product compared to the small batches used to develop the product. Second, they learned that soil conditions may lead to the presence of other unsafe microorganisms that can lead to lost product later in the process. The innovator learned about the importance of checking the soils where they source their inputs, otherwise they risk product and monetary losses from needing to throw away contaminated porridge. Finally, the mentor counseled them on specific aspects and conditions to look for in a food processing facility to ensure safe production. While the innovator notionally understood that they would have to figure out food safety at some point, none of these issues were known to the innovator in sufficient detail prior to their mentorship by the researcher in the Food Science department.

With this knowledge in hand, the innovator identified a production facility 90 minutes from Kampala. The mentor, however, was not done advising the innovator. They provided the innovator access to a lab at Makerere where they tested the product from the production facility to ensure it met basic safety standards.

Justine Nitele, USAID

Initially, the innovator had done general research on these issues, but they did not have sufficient knowledge to identify all of the factors that go into meeting safety standards. The innovator was a nutritionist by training whose expertise was with vitamins, minerals, and their uses by the human body, not someone whose expertise included the science of microorganisms and supply. During the mentor's support to the innovator, they also helped the innovator make an instant version of the porridge. This required adding an additional step at the processing plant whereby extrusion processing is carried out. This provided an additional product for the innovator to sell and extended the shelf life of the product for up to six months. It was not something the innovator had planned on at first, but once the mentor explained these added benefits, the innovator decided to add this product to their business.

This case demonstrates evidence that RAN's affiliation with a HEI enabled this innovation to progress toward scale. Needsfinding arguably accelerated the product development process as it demonstrated that potential consumers preferred a different mix of ingredients, but RAN's more significant contribution to this innovation was connecting them to a mentor at Makerere with a specific domain of expertise. The innovator learned of issues they had to solve outside their knowledge base at the beginning of their path to scale so they could solve them proactively. Without this mentor, the innovator would have likely run into each obstacle individually as they scaled production, solving each issue through an iterated process of trial and error. Access to the expert at Makerere – arguably – shortened the timeline to scale by identifying all these issues up front.

Factories themselves may have provided this information as part of their sales pitch to produce this innovator's porridge, but given the innovator's lack of knowledge in this subject at the time, they would

have been ill equipped to determine what information was most relevant. Access to this objective expert then solved what economists call an information asymmetry, putting the innovator on equal footing with production facilities. Moreover, the mentor provided access to their laboratory to test safety aspects of the product, ensuring they would not have to rely on the production facility's data. This innovator made three distinct changes during their process.

MAIZE THRESHER

For the third agriculture example, RAN has supported an innovator who built a maize thresher that winnows pieces of cobb (chaff) from the grain simultaneously while it separates the kernels from the cob. Generally, farmers must sieve maize after threshing to separate the grain from other material, but with this thresher it is completed in one step. The innovation is mobile and can process 1000 kg of dried maize in an hour. By contrast, most farmers in the area of Uganda where this innovator works can only process 600 kg of maize a *week* by hand.

The thresher itself is 3.6 million Ugandan Shillings (UGX); 2.4 million UGX for the machine itself, plus 1.2 million UGX for the engine (approximately $980 USD total). For comparison, other threshers that market cost approximately 3 million UGX for the machine, plus 400,000 UGX to 1.4 million UGX for the engine, depending on the size and type of engine procured.

At the time of the interview, the thresher was similar to its original prototype, only more durable. Specifically, the innovator redesigned the base of the winnowing fan to reduce shaking and to stabilize the thresher. In the original model, the belt wore down too quickly because of excess shaking limiting its durability. The thresher is also slightly more efficient after the innovator experimented with different spacings between the maize and the motor, but this is a slight adjustment to the machine rather than a wholesale change in its design. The innovator is content with the current model as farmers generally provide positive feedback. The principal obstacle at this point is how to identify a market for the

Morgana Wingard, USAID

thresher in Uganda as the innovator believes the thresher is still too expensive for a single farmer to purchase. As a result, the innovator is in the process of completely changing their business model.

Rather than trying to sell individual machines to individual farmers, the innovator is in the process of opening a rental business in a rural area so farmers can rent the thresher for temporary use. The thresher processes maize so quickly that most farmers only need it for a couple hours a season. Due to this, the innovator thinks that a rental model might be a viable path to scale. Once the innovator began down this path, they began to realize other problems in the post-harvesting supply chain exist and plan to purchase a dryer for the rental business as well so the entire harvesting process can be done in less than one day. And finally, with the potential for so much output being processed by the rental business, they plan to build a silo to store maize for farmers for a small charge so crops can be sold when prices are higher, generally several weeks or months after harvest.

In addition to funds, this innovator received business training from RAN and was invited to innovation exhibitions. They said that RAN introduced them to a local innovation group made up of different types of engineers who were especially helpful. Although this innovator was an engineer by training, they had only just graduated from university. Most of their engineering knowledge was in the classroom, so they needed technical help turning their idea into a tangible, working prototype. They got this assistance from the innovation group RAN introduced them.

To help the innovator identify a distribution channel for the thresher, RAN introduced the innovator to agriculture dealers who might be interested in purchasing the threshers directly, but the innovator wanted to maintain flexibility with their business model and control over the design moving forward so they declined this offer. The innovator preferred building an entire market and supply chain to turning their invention over to another private entity.

This innovator did receive help during the development process from engineering faculty at Makerere as they built their machine. Though they conducted needsfinding, the innovator did not identify a specific piece of information from it that they incorporated other than a desire to make the thresher less expensive. The innovator received help from RAN on a scaling strategy, specifically an introduction to an agricultural supplier who could enter into business with them to sell their machine, but the innovator turned them down, preferring to build their own market from the ground up. They made three distinct changes during their process.

MOBILE PLATFORM FOR MARKET COORDINATION

Namasubo Zabina, USAID

The next innovation is a mobile platform for organizing agricultural markets. The innovator created this platform because agriculture markets, despite their importance to the poor in Uganda, are disorganized, ensuring many profitable transactions do not take place. Moreover, farmers have limited access to credit so few farmers can afford to use high quality inputs. The innovation addresses three principal development challenges: a lack of liquidity when inputs are needed, high transportation costs faced by farmers for inputs, and information asymmetries in local insurance markets. By connecting farmers to the microfinance institution (MFI), it addresses the liquidity issue, and by organizing purchases, transport costs can be spread across multiple farmers. The agriculture insurance reduces risk across the entire system by ensuring there is money to pay back loans in case of crop failure. Insurance payouts are made based on satellite data— not farmer reports or experiences—which can measure the presence of flooding, large scale crop failure, and other systematic changes to the landscape. Insurance payouts are then based on events that each farmer faces and independent of individual farmer's behavior, reducing concerns about what economists call moral hazard (i.e. a change in farming behavior due to the fact that insurance will cover lack of output regardless of effort). Moreover, satellite data allows the insurance provider to calculate weather-related losses across regions, without relying on farmer reports or the costs associated with gathering those reports.

This innovation started as an e-service for agricultural extension services, and it was originally funded by a different USAID activity.[15] Funds were key for moving this innovation forward because farmers were unwilling to pay the mobile fees required to send requests to the platform. Local mobile providers in Uganda will waive SMS fees once a service like this gets 25,000 users, but this was not achievable when the platform was first created. The innovation expanded to include additional services beyond just extension services because the innovator saw a gap between the demand for services and the ability to pay. Extension agents would provide information to farmers in villages, but that information was often not implemented due to a lack of liquidity and other issues within rural agricultural markets. This platform was built to solve these broader systemic problems.

The innovator used RAN funding to expand their operations to include forty agents for extension services and set up partnership agreements with the MFI, insurance provider, buyers, input dealers and others on the platform. The innovator identified their partners via networking at agriculture meetings and events in Uganda, which they regularly attended. RAN also helped build out the structure of their business by providing training via financial management workshops. Finally, working with RAN made it easier to attract investors, equity, and access bank funds because RAN has a good reputation within Kampala. The innovator stated that RAN's stamp of approval sends a positive signal about the innovation and helps open doors when asking for meetings with other ecosystem actors.

This innovator did not consult experts at Makerere. They had reached out to local extension service agents early in the process to build their original idea and through those contacts learned how inefficient markets prevented better development outcomes. Though RAN later assisted with this process, it appears they began on their own initiative. Finally, they have scaled through identifying extension services agents to work with and through identifying business partners. For the latter, they have received help from RAN through organized events as well as at other events in Uganda. They did note that RAN's reputation extended into the financial sector, which has helped increase the success of their own efforts at raising funds. They made three distinct changes during their process.

[15] Specifically the Higher Education Solutions Network Lab at Michigan State University (HESN link).

HEATHCARE INNOVATIONS

DIAGNOSTIC KITS

Josh Etsney for USAID

In the healthcare space, RAN supports an innovation developed to improve the efficiency of detecting malaria at a lower cost. The innovation is a diagnostic kit that produces a diagnosis for malaria, using software on a small device that can simply be plugged into a laptop or phone. Results of the test are sent to an internet-based platform using the global position system (GPS) so malaria outbreaks can be mapped spatially as they are happening. The innovation is an improvement on current alternatives as it is 15 times faster than current malaria diagnostic tests; patients get their result in 2 minutes, rather than 30 minutes. Moreover, the spatial tracking of outbreaks provides information to health officials about where current cases are being reported in near-real time.

The first version of the kit was created as a class project at Makerere University. The innovator began by simply taking measurements from light reflected off one's skin with basic equipment and feeding those readings into a statistical model. This version used a small LED to reflect light off a patient's skin to collect data on red blood cells. However, these measures were too noisy statistically speaking so when they were fed into the model, they did not produce accurate predictions. The second version of the diagnostic kit was much like the first, but the innovator included a shield for the device to eliminate extraneous light. This did improve the quality of the reading, but not enough for predictions to be sufficiently accurate for diagnosing malaria.

Next, the innovator redesigned the kit to focus on a single parameter. Rather than using all the information read from the reflected light, as each parameter included its own measurement error, it focused on one piece of information to predict the probability of infection. Simplifying the model

improved the percent of the variation explained by the test, but it was still not accurate enough to be used on patients yet.

RAN saw potential with the idea and supported the innovator, beginning with needsfinding. From needsfinding, the innovator realized that their original idea – that individuals could conduct malaria tests themselves in their own houses – was not viable. Self-diagnosis without follow-up medical care was problematic so they shifted needsfinding to clinics and hospitals. Now they aimed to develop a testing kit for nurses and other medical practitioners. This shift had a substantial impact on their thinking and ultimate design.

The fourth iteration of the kit introduced two separate parameters to the predictive model, measured from two separate instruments. The first measure incorporated magnets to attract a magnetically charged secretion that is specific to the malaria parasite to a concentrated location so cleaner readings could be taken. The second measure came from drawing blood. Blood is put on a piece of glass and light is shone through to produce a cleaner measure of the second parameter as well (blood with the malaria parasites absorbs some wavelengths when exposed to light). Both measurement techniques improved the accuracy of the predictive model because it reduced measurement error in the data. However, both measurements require a level of specialized training beyond what your average patient has received. For example, collecting blood samples at home might prove difficult and potentially cause harm if done incorrectly, but is likely fine when done by nurses or other health professionals.

Once the innovator moved from thinking about households as their end user to a focus on clinics, they began looking for a development partner that could cheaply produce a magnetic device needed for the kit. They identified a potential partner from Europe during a TED talk they attended in Lusaka, Zambia and at the time of the interview, they had begun discussions with them to explore whether they could manufacture certain parts of the kits.

RAN's insistence on needsfinding changed the trajectory of this innovation's development process significantly, from one end user to a completely different end user. Importantly, the innovator stated that they were not equipped to conduct needsfinding in health clinics prior to their engagement with RAN. They said RAN facilitated access to health workers and helped organize needsfinding in clinics. RAN also arranged for the innovator to present their idea to experts on malaria diagnostics, who gave critical feedback that shaped the path of their innovation process. Finally, RAN helped the innovator with legal aspects of contracting their partnership with the European firm they met in Lusaka.

BUILDING THE ECOSYSTEM

How does an innovator legally and ethically move their innovation toward a viable product that can scale in Uganda? Especially for an innovation whose development entails risk to those subjects assisting with its testing. With this innovation, individuals must have their blood drawn for the diagnostic kit. While the risks involved with that are minimal in some spaces, they may be much higher if done unsupervised in private homes. Moreover, testing a healthcare innovation may simply be unethical in certain contexts. One solution is for a public regulatory agency to be created where innovators can register their innovations, have testing protocols reviewed, and to provide guidance on ethical testing of innovations in development. While agency does not yet exist in Uganda, individual institutions such as Makerere University, can serve as a bridge to the future, by providing this oversight.

In addition to the above, the innovator said RAN helped them with testing the kit beyond needsfinding. Specifically, the innovator said that Uganda lacks a formal infrastructure for medical trials. If an innovator is not affiliated with a small number of institutions in the country, such as a university with a medical school, then someone who wants to test their innovation typically would face an insurmountable hurdle. RAN introduced the innovator to the appropriate government agency in Uganda that would regulate and test their kits; however, there was a regulation gap for devices of this nature. Regulations tend to be written for products that exist, not necessarily for products that may be invented in the future., So for innovators working on the edge of new technologies, this is an expected, yet difficult hurdle to overcome. This has important implications for scaling innovations as there will often be a delay between an innovation's development and the establishment of regulations to ensure that it is safe. At the time of the interview, the innovator believed that the relevant regulatory agency was writing guidance in response to the joint discussions between regulators and the innovators (after RAN's introductions), but none had been published yet.

This innovator conducted their testing under the supervision of one of Makerere University's Internal Review Boards (IRB). The Ugandan Government agency whose jurisdiction would oversee this innovation provided a waiver so that the innovator could conduct trials at Makerere, which allowed them to continue testing and iterating their innovation. Had this option not existed, the innovator would have had to wait for government oversight functions to be built, or to simply move ahead testing their innovation with no oversight, potentially putting test subjects at risk. The innovator team's connection to RAN, and Makerere University, permitted a new path to be pursued.

This situation was not unique to this innovator. In fact, it was common for many of the healthcare innovations. Other healthcare innovators were introduced to the relevant authorities by RAN and provided written waivers to develop innovations under Makerere's supervision. Although this

innovation found a business partner at an event not organized by RAN, the contracting assistance provided has been useful as they navigate the next steps and has helped them move toward scaling production. They made five distinct changes during their process.

PEDIATRIC NEBULIZER

RAN also supports an innovator who developed a nebulizer to improve the delivery of aerosol medications to pediatric patients with asthmatic conditions. This innovation is unique in the healthcare space because it does not require electricity, making it useful in rural clinics where power is often intermittent. The nebulizer also uses a locally produced pump and other local components, so it is cheaper than comparable nebulizers on the market.

This innovation is earlier in the development process than the diagnostic kit in the previous example, however, it has already begun to follow a similar path. According to the innovator, the first prototype of the nebulizer was "basic, big, and bulky" with "very little science" in the design. By "very little science" they meant that it worked, but it was not clear how safe it was because the volume of children's lungs varied widely and no data had been collected yet to determine what range of volumes the nebulizer would need to serve. Because of this, it is important to ensure the correct amount of vapor is inhaled relative to the capacity of the lungs, so the innovation does not cause injury to the child.

To improve upon the original prototype, the second version set out to ensure there was a way to control the pressure exerted by the nebulizer. The innovator had a medical background in pediatrics, so they were aware of the need for this device, although they did not know how to engineer it safely. They needed the expertise of an engineer and found such assistance from the Instrumentation Lab at Makerere University. At this Lab, they got help from two people: a mechanical engineer and an electrical engineer.

MORGANA WINGARD FOR USAID

With a new prototype complete that would not physically harm patients, RAN suggested putting all the components into a box so it did not intimidate children. Needsfinding generated the same feedback, as the children were frightened by all the tubes and valves, so the innovator was already planning to make this adaptation when funds became available. At the time of the interview, the innovator was searching for funds to further pilot test the device, testing that went beyond needsfinding and would be closer to a clinical trial. The innovator was in talks with a venture capital group from Kenya to see if they would invest in the device and to determine what terms would be required.

The innovator's own network, as well as connections across Makerere via RAN, were instrumental in developing the device. Without access to experts in the Engineering Department, they were not sure how the device's end-state would have looked. Connections made via RAN allowed them to disseminate information about the innovation to a wider audience, where they met the Kenyan investment group they were in talks with at the time of the interview.

While the innovator was still early in their development process, they had begun to focus on the business side of things, for which they planned to leverage RAN's services such as business development training. The innovator had also begun to investigate regulations that would govern their innovation, but like other Ugandan innovators, were unsure from where to seek approval (they had not discussed this with RAN at the time of the interview). They said Uganda needed standard operating procedures so that innovators would know how to engage the government. Specifically, this innovator said a "one-stop shop" is needed, and the fees should be clear and public. The complexity and decentralization of the regulatory environment in Uganda has led to innovators sometimes paying application fees to the wrong authorities. Also, they said patent rights needed to be stronger and the process for getting a patent needed to be "demystified" as the processes remained opaque to regular Ugandans. The innovator had not shifted to scaling strategies yet, so they had not experienced barriers in that space. However, RAN had helped them begin to think down that road by connecting them with Kenyan investors, considering how the innovation might be perceived, and considering the regulatory and approval work needed in the future. They made three distinct changes during their process.

WATER PURIFICATION

The next example in healthcare is a mobile water purifier that purifies fresh water sufficiently for human consumption. The purifier uses a two-stage purification process. First, it filters the water for larger solids through gravel and sand and then passes the water through an activated carbon filter, which catches smaller solids. Second, it uses a solar-powered ultraviolet light to kill microbes in the water. The result is potable water, even from contaminated sources. It is designed for communal locations, such as schools, refugee camps, and community centers in rural areas with intermittent electricity.

The purifier is large but portable. It can be moved from one part of a school (or community center) to another part of the school (or community center) when needed (to fill water reserve tanks, for example). Moreover, the purifier uses materials available in Ugandan markets. It is different from other purifiers because it runs on solar energy, and does not require a consistent grid current, which means it can be used widely across Uganda and specifically in places lacking a reliable power grid. The most recent model includes a heavy metal detector that measures levels of heavy metals in the water, including iron, lithium, and magnesium, common contaminants in Uganda that make water undrinkable. This addition does not remove metals but provides additional data on whether the water is safe for consumption. Finally, the purifier is unique because the flow of water emanating from its nozzle(s) is constant. Other purifiers fill up a container and let water slowly filter through using gravity

before it can be used. With common purifiers, water is filtered into a reservoir slowly, drained, refilled again slowly, and drained again, etc. This purifier ensures that the water can be drunk in real time so people can use it from the moment it turns on without waiting.

The purifier has undergone several changes as the innovator has refined the technology. For example, needsfinding supported by RAN demonstrated that power outages in villages in this part of Uganda are an issue. The initial design used electric current from the power grid, but the innovation was altered to run on solar power. Also, because measurement laboratories capable of doing water testing in Uganda are extremely far away, several hours in fact, from the villages where the need for this innovation was greatest. The heavy metal detector was added to the design. The metal detectors provided real-time information during assembly and testing of each unit, reducing costs and the burden of a full day round trip to drop off and pick up water samples for testing, adjustment and retesting, reducing costs in the manufacturing process.

From discussions and data collected during needsfinding, the innovator decided to make the water purification system portable because some households and buildings had multiple water tanks at different locations, all of which they wanted to be able to provide safe water. End users told the innovators they would need to provide safe water at different times in different places for different events. They also included an option for a solar pump in addition to the solar powered UV light because some possible locations (including a refugee camp) did not all have the capacity to elevate (either through structures or a rise in elevation of land) water tanks for a gravity-based system to work.

At the time of the interview, the innovator incorporated their innovation into a legal company with an eye towards sustainability. Establishing a legal business would allow them to sell their product to other established entities, increasing their potential customer base, and create a paper trail for future financial expansion. Their first customer was a church, but they have since expanded their customer base to NGOs and individual households. The innovator has also added an attachment that connects to piped water because personal research showed that by the time piped water gets to the tap, much of the chlorine has been lost and microbes have entered the water, making it less safe to drink than commonly believed in Uganda.

RAN helped the innovator with networking by inviting them to innovation events, but the innovator did not recall specific, tangible outcomes from these events. RAN also provided mentorship on finances,

business development, and encouraged flexibility with the innovation. Importantly, RAN also provided office space for this innovation team as they got their company established. Through RAN's encouragement, the innovator reached out to potential customers in Uganda, with some success. For example, "cold calling on office doors" with NGOs who fund safe water activities has led to finding a few customers. The innovator says a major hurdle for them is the mindset in Uganda; people prefer foreign technology because they think it is superior. As a result, the innovator has found more success selling their purification system to foreign NGOs than to individual Ugandans or local organizations. At the time of the interview, sales were increasing slowly because they relied on word of mouth to find customers.

This innovator team relied less on RAN's access to expertise at Makerere than they did on RAN's own staff. RAN pushed them to present their system as often as possible to as many people as possible. RAN's insistence on finding staff who can help navigate innovators through uncertain innovation processes demonstrated its value to this innovator. The innovator has found success through less structured, intangible support from RAN; they rely heavily on their mentor's advice and encouragement. The innovator did incorporate as a company, however, a step that began following a RAN workshop. Needsfinding was supported and funded by RAN, which led to several changes in the design. However, the innovator used private laboratories outside the University to test water quality; they did not use this type of resource that might have been available at Makerere like other RAN innovators. They made five distinct changes during their process.

REFORMING HEALTH CURRICULUM

David Rochkind, USAID

The final health innovation included here is a co-ed sensitization model of menstrual hygiene education. This innovator created a curriculum on menstruation for children in Primary 5 (P5) through Primary 7 (P7) grades in Ugandan schools. It is innovative for two reasons: one, the curriculum is geared toward both boys and girls rather than just girls, and two, it starts in grade P5 rather than P7, as is common across Uganda.

If the student menstruates prior to P7, menstruation education is often taught by senior female teachers to girls one-on-one when they experience their first period *and tell the teacher*. This, of course, assumes the school teaches the standard curriculum. According to the innovator, however, there is often no formal health class in many public schools. The standard curriculum, which begins in grade P7, can be too late as some girls will start puberty earlier.

This innovation was initially aimed at just girls and simply moved the topic earlier to P5, so that girls knew what to expect before they experienced menstruation. The curriculum began with a basic teaching model using cards with information printed on them. The innovator began to include boys, however, after they heard stories from girls in the class that highlighted many boys were ignorant of these changes faced by their female classmates. This ignorance affected many girls through comments and even bullying. The innovator concluded that to address the bullying associated with the start of puberty, boys needed to be included in the curriculum.

The innovator conducted internet research – reading websites and studies from other countries – and confirmed from the desk research that co-ed classes are a better educational model. Their research led to additional online explorations, which again led the innovator to make more changes focused mainly on the best practices concerning the format of instruction. The innovator moved from printed cards to demonstrations using supplies such as pads. However, the innovator realized that there would be costs associated with buying pads that would make this form of education difficult, despite the studies that suggested this model of instruction was preferable. Further, the innovator realized that the costs associated with hygiene products was not only an issue for developing the training materials, but was also a hurdle for the girl's themselves, as girls could not afford hygiene products from the market. Since then, the innovator has altered the curriculum to include teaching students how to make their own pads, so each girl has at least one pad for their first period and the knowledge to make additional pads in the future, when needed. Finally, the curriculum added information about how to keep supplies sanitary. The innovator said they added these features to the curriculum because RAN pushed them to think about how to ensure the information being presented is sustainable beyond the classes themselves.

Further, RAN helped the innovator learn about conducting financial analysis so they could build a sustainable organization. RAN also helped the innovator test their approach through a sponsored pilot that was reviewed by a Makerere University IRB, an important step given sensitivities around the topic, the age of the end users, all of whom were minors, and because the topic was directly related to bullied students. The innovator had hoped for a mentor from RAN, but that mentor never materialized.

RAN did help the innovator translate medical information in the curriculum to the appropriate level of students in P5. Despite the lack of mentorship from RAN, the innovator was able to make their own connection with a professor in Makerere's Physiology Department who supported the team while they developed the content. The innovator stressed that being connected to Makerere University was important for them. It allowed them to make contacts with experts and to also see additional funding opportunities, as many organizations come to the university to advertise calls for proposals, sometimes through RAN, but also through other institutes and departments there. The innovator identified two opportunities for funding advertised at Makerere. Although these opportunities were identified outside of RAN, they utilized RAN's services to put together financial information and a progress report for those applications (applications were still outstanding at the time of the interview). The innovator's main challenge was that this innovation could not be scaled through the private sector and requires public donor funding, which is limited. They made two distinct changes during their process.

GENDER BASED VIOLENCE

COLLECTING DATA

Within the gender-based violence (GBV) category of innovations is a mobile platform that aims to improve the quality and reach of data on GBV across Uganda. This innovation seeks to provide deidentified GBV occurrence data in near real time so others, including but not limited to donors and NGOs, can make informed programming and policy decisions. The innovation is a web-based platform that collects information on GBV and enters it into a database, which is then aggregated and presented for public consumption using different visualization formats. Data for this platform is collected from social workers who volunteer at churches, community-based organizations, police stations, and judicial institutions across Uganda. RAN helped the innovator design and put a consent process in place for the social workers to implement so victims, if they consent, know their information will be included in this database. The public facing visualizations are updated every 36 hours and thus provides near real-time and geolocated data. It uses a machine learning algorithm to clean and aggregate the data more efficiently than a human, allowing for new data to be incorporated more effectively. This innovation is different than other sources of data in Uganda because it is regularly updated and because it includes information on responses to GBV and access to services by victims.

Mohamed Abdullah Adan, USAID

This innovation represents an improvement over the status quo as while the Ministry of Health (MoH) collects GBV data monthly,[16] it is not cleaned nor presented *regularly* in an easily readable format for others to use. Moreover, the MoH data is not automatically mapped spatially to see incidences of violence across Uganda. At the time of the interview, the data collected by this innovator was being

[16] In the MoH's last public report published in 2019 (link), they collected and ***presented*** data on incident counts, sex, age (including minors), and the relationship of perpatrator. The MoH further broke down incidences into sexual, emotional, and physical violence. Finally, the MoH collected and presented data on female genital mutilation, forced marriage, and sex trafficking. This innovation collects the victim's sex, the date of the occurance, number of previous occurrences, whether the victim was given medication for treatment, what other relief services they accessed, whether any occurrences have been reported to the police, what action police took, sex of perpatrator, age, and relationship of the perpetrator. Also, social workers code where on the body injuries occur, distinguish between sexual, physical, and emotional violence from the victim's narrative of the event. If consent for data collection not given by victim, only aggregated frequencies of the date of the occurrence and sex of victim are included in platform. If a victim is a minor and present with their legal guardian, consent is asked of the guardian. If a minor is unaccompanied, only the incident is recorded as a count with no accompanying information other than a minor was involved.

used by UN Women to identify where to allocate resources, and as evidence in local judicial proceedings. NGOs working in this space also use it for resource allocation decisions. In short, this innovation is a public good for other actors in the GBV space.

The innovation began by simply collecting data so the innovator could conduct their own analysis and create their own visualizations. At first, the innovator did this manually and data collection was less systematic - akin to convenience sampling - so the innovator did not present results publicly. The first change to the innovation was to move toward more systematic data collection. The innovator then decided to create a website after a professor showed the innovator the gun violence archive in the United States,[17] and Harris maps of Egypt,[18] as models of data visualization tools for public consumption.

Needsfinding for this innovation was done in Northern Uganda where the innovator spoke to government representatives, police, and victims. For needsfinding with victims, Makerere's IRB again proved important, ensuring the innovator mitigated risks to this population. From needsfinding, they realized the need to sync the data they collected to government with "Form 3A," a document that is collected by the police when there is a medical exam following gender-based violence.[19] The innovator also redesigned the mobile platform to collect data using a 'touchscreen' to identify body parts where injuries occurred so instances of GBV were measured in the same way as the official police statistics. The victims themselves, however, do not use this touchscreen. Social workers interviewing the victim about the incident enter this information from the narrative account provided by the victim. At the time of the interview, their data input device had recently been re-coded and the innovator planned to continue needsfinding by revisiting the police who initially gave them this idea to see if it helped them complete data entry. The innovator initially did this to make the data more useful to police leadership so they could assess their performance, however, the innovator has found minimal interest from the police so it serves only to reduce measurement error in the data.

As a public good, the innovator must reduce costs as much as possible to ensure the innovation's sustainability. To do this, the innovator plans to build their own self-contained system from scratch,

[17] https://www.gunviolencearchive.org/
[18] https://www.scribblemaps.com/maps/view/Harris
[19] https://www.upf.go.ug/download/medical-examination-of-a-victim-of-sexual-assault-police-form-3a/

which will save them money in the future to run the platform, compared to the current Google cloud service they use at a cost of 300 USD per month. The innovator was also writing computer code to clean common mistakes from the incoming data to increase efficiency, reducing the need for human labor to update the database. Finally, the innovator was looking into how to use SMS data rather than a mobile app because cell phones have wider coverage and are cheaper for people to use than the current, internet-based platform. These improvements were suggested by an app and web developer introduced to the innovation team by RAN as an informal mentor.

The innovator credits RAN with pushing them to think about how to make this public good sustainable and how to conduct a needs assessment (i.e. needsfinding) for this innovation. Moreover, RAN connected the innovator to a mentor who has helped them think through how to build and develop this innovation from a technical perspective – the construction of the platform from scratch, rather than relying on off the shelf web services – so that costs might be low enough to reach sustainability. The final obstacle, to which the innovator admittedly does not have a solution yet, is that they do not know which national government agency they will need to approach to get approval to scale this idea. They have gotten assistance from police and other local officials with needsfinding, but to scale this nationally they will need to ensure they are operating legally and with government support.

This innovator has been mentored by a software developer whom they met via RAN. While the data collection itself is by secondary parties such as non-profits, and not victims themselves, reducing risks to those involved arose with the needsfinding work completed,[20] RAN's insistence on needsfinding did lead to harmonization with official public reporting systems. Moreover, RAN's facilitation of needsfinding reduced barriers for the innovator to conduct it initially. However, after that first nudge, the innovator continued to do needsfinding by themselves to continue improving the innovation. Whether this innovation scales and remains sustainable will be decided by two factors, whether they can rebuild it to lower recurring costs and whether they can figure out which regulations to which they might be

[20] IRB's assess whether the implementation of research changes the risk to subjects for taking part in the research, not whether those subjects would be at risk outside the research. In this case, since the NGO collects some information for their own purposes and shares aggregate numbers to the innovator, the additional risks to subjects due to the needsfinding interactions are minimal.

subject. RAN has supported the former through the connection to a mentor, while the latter remains on the innovator's "to do" list. They made two distinct changes during their process.

BRACELET FOR EMERGENCIES

The final innovation discussed is a bracelet that can send a help signal to a pre-specified cell phone number. A woman wears this bracelet so she can inform someone that she is uncomfortable and at risk of sexual assault. She only has to push a button on the bracelet, and it sends a help message in a local language. On the receiving end, the phone uses Google Maps to share the location of the person wearing the bracelet.

This innovation is unique because similar innovations require smartphones to send and receive the signal. This means that the person in danger needs internet service ***and*** has to first open the phone and the application to send the signal. If under duress, these additional steps may not be possible. The system used on this bracelet is a standalone system, using only SMS, which is also a more widely available, reliable, and cheaper method.

The first prototype for this bracelet had no web system behind it so it only sent latitude and longitude coordinates to the person receiving the message. The innovator quickly realized, however, that people would not be able to make sense of such coordinates – even if they knew what they were – so they began to build a system that converted them upon receipt into something more understandable. Specifically, they built an application using Google Maps to convert the coordinates to a map location on the receiving end of the signal. The innovator then conducted needsfinding with women who – the innovator thought – might use it. They told the innovator that it should be available in local languages.

After adding a language option into the software, the innovator needed to find a way for it to operate for a prolonged period of time. During testing, they realized that the battery drained too quickly. Since women would not know when they might be attacked, the battery life would need to be long. Initially, the innovator added a rechargeable battery with longer life, but that battery required a laptop to charge. Since many people do not have laptops, they had to switch to a different battery and charging system again.

The innovator tested the actual prototype with the help of two organizations in Kampala that work with survivors of GBV. In an interview, three members from one of the organizations said that the innovator

focused on functionality at first, but as they tested it with women, they realized that had to blend in with other accessories. Needsfinding uncovered that women were open to wearing a bracelet that had this function, but the innovation also needed to look attractive and be fashionable. If the bracelet is too bulky it would not blend in with a woman's clothing and accessories and might not be regularly worn, making it less effective, as a result. At the time of the interview, the innovator was working on making a sleeker version so women could wear it without drawing undue attention. While the new battery was less bulky in the most recent version, the innovator recognized that additional improvements would still be valuable.

Staff at this NGO said that they helped the innovator because this bracelet was unique; most devices like this one require technological knowledge beyond the scope of women with low educational attainment. But they said any woman could use this bracelet once the phone application on the receiving end was established. Moreover, during an attack, this innovation only requires a woman pushing a single button, rather than opening a phone, opening an application, making a call, etc. so the innovator's design was recognized as more practical than others on the market or in development.

Staff at the GBV NGO noted that they did not meet the innovator at an event. The innovator appeared at their office one day and explained who they were and asked if they could talk. The innovator explained what their innovation was and that they wanted to get feedback from them. To the innovator's surprise, NGO staff suggested that the innovator talk directly with sex workers and victims of sex trafficking, women with disabilities, and women who trade on the street for feedback about what they would want. These women are the most vulnerable to attacks and could gain the most from the innovation. These conversations led the innovator to rethink who their target end user would be. NGO staff also pushed the innovator to talk to the LGBTQI community, whose members are often targeted for "corrective rape," i.e. forced intercourse to turn a homosexual female into a heterosexual female.

While few experts at Makerere University were consulted for the development of this innovation, the process of needsfinding would be iterative, but had already led to significant changes in the design and in defining who the intended end user for the innovation was. For this innovation, needsfinding would take place in at least two steps. The first step, which had been completed by the time of this interview, focused on the design of the bracelet, solicited general feedback on the idea, and asked whether they would be interested in wearing it. This step was conducted informally without university supervision, as it was focused primarily on design and did not record responses. The second step, which had not been

done at the time of this interview, would focus on the effectiveness of the bracelet. This step would entail potential risks to women involved in the research because using the bracelet would mean instances of violence would be recorded, raising serious privacy concerns, among other risks. For this step, supervision by Makerere's IRB will play a pivotal role in mitigating risks faced by women involved in the research.

RAN had begun to encourage the innovator to think about options for scaling this innovation. Specifically, they have connected the innovator to potential partners, including large international NGOs who might become buyers. Moreover, they helped the innovator set up a company and taught them the needed financial and accounting skills necessary. RAN also recommended the innovator for a competition in Nairobi that helped them increase visibility and as a result, the innovator won a fellowship to the United States where they presented their innovation during the summer of 2019. RAN also connected the innovator to a local company that helped improve the battery design, something the innovator was not equipped to do themselves. Finally, this innovator uses office space at RAN as they get their company off the ground. They made three distinct changes during their process.

SUMMARIZING INNOVATION HISTORIES

Table 1 presents descriptive statistics from the survey to situate the cases chosen in the previous section. All but three innovations described above make either two or three distinct changes, just above or below the sample average of 2.6 for all innovations selected. There were two exceptions to this trend, both agricultural innovations.[21]

[21] Note not just the wider range in Table 1, but also that the standard deviation is equal to or higher the other categories, despite having more observations from which to calculate the s.d

TABLE 1: INNOVATION HISTORY SUMMARY STATISTICS

TABLE 1 INNOVATION HISTORY SUMMARY STATISTICS: NUMBER OF CHANGES TO INNOVATIONS			
	Mean (s.e.)	Range of Values	N
Total Sample	2.6 (1.2)	0 – 5	45
Agricultural Innovations	2.3 (1.3)	0 – 5	22
Healthcare Innovations	2.8 (1.3)	1 – 5	13
GBV Innovations	2.8 (0.96)	2 – 4	4
Other Innovations	3.2 (1.2)	1 – 4	6

Note: A Oneway ANOVA test produces a F statistic of 0.8 indicating differences in group means are not statistically different. Running a Oneway ANOVA test on a sample of just the Agricultural and Healthcare Innovations produces a F statistic of 1.0 indicating group means are not statistically different.

Statistical tests applied to this data show no statistically significant differences across the technical sector groups. Descriptively, however, the data suggest that healthcare innovations undergo more changes than agricultural innovations, which may be due to the fact that many healthcare innovations require a higher level of technical expertise and further development before they can be considered to be tested on people, but these differences are only suggestive and need to be confirmed with additional data collection as sample sizes are too small. Similarly, all other innovation types iterate more than agricultural innovations, but as they represent even fewer observations (sample size, N, is limited) in the data. Future research may want to unpack these descriptive patterns to explain why agricultural innovations follow more diverse paths and what leads to additional changes, but the data here are insufficient for this type of analysis, and are only able to suggest directions for future work.

WHERE DOES RAN GO FROM HERE?

At this point, RAN has built an innovation program that encourages testing and iteration through applied research. RAN has built an infrastructure that lowers barriers for innovators, ensuring not only that needsfinding is possible, but done for most, if not all, of the innovators they support. These innovation support activities were funded – and scaled - through USAID's Higher Education Solutions Network activity. And while these funds were meant to jumpstart the founding of RAN, and played a key role in RAN's expansion, they were never meant to be provided indefinitely. RAN was obviously cognizant of this from the beginning, nevertheless, a member of RAN leadership described the end of this initial funding source as a 'sobering moment.' This was because other funding sources they could apply to were much smaller.

As this initial grant was nearing its end, RAN's headquarters in Kampala brought together its partners to discuss a way forward and to make changes to their funding model. The first change they made was that RAN pivoted toward a buy-in model whereby they could access donor funds in return for some innovation or research related activity. By this point, they had built-up a unique network and the infrastructure underpinning it; a network spanning large parts of Africa. They thought, if a donor needed assistance with a research or innovation activity in an African country, RAN likely had connections there and could perform whatever function was needed, likely at a lower cost than international firms. This strategy has demonstrated some early success. Since the original HESN award ended, RAN has secured over 15 contracts or grants from UN Women, the Canadian International Development Agency, USAID Grand Challenges, USAID/Uganda, Johnson and Johnson, and others. RAN also joined two research awards/contracts managed by the USAID Global Development Lab, which provides an avenue for them to continue to receive USAID funds on a project-by-project basis.

Within Uganda, RAN focused its attention toward the central government, specifically, the Ministry for Information and Communications Technology (ICT). The director of RAN – along with Makerere's central campus and administration – took part in discussions with the Ministry of ICT about the role of innovation in Uganda and the role for government funds in starting local innovation programs. Initially, the Ministry was skeptical of Makerere's ability to manage such large amounts and to implement an innovation program on the government's behalf, but RAN's founding director pushed back on this skepticism. They pointed to RAN's work with HESN and argued that this work demonstrated the University was able to manage large grants effectively. RAN had built up financial controls and processes within the School of Public Health for HESN and could do the same at Makerere's central

campus for the Ugandan government. As a result, he was promoted to a position at Makerere's central campus to build these processes and controls into the institutional structure of the central campus.

Ultimately, Makerere was able to convince the Ministry of ICT to provide funds to the University to oversee and implement an innovation program. The first transfer was for $8 million in 2019. The Ministry has since transferred a second $8 million transfer from the following fiscal year and $2 million for a COVID-19 response innovation program. Although this new Makerere-based innovation fund is located at its central campus, it was RAN leadership bringing their experience to the central campus that positioned the University to demonstrate it could manage these funds effectively. Moreover, RAN is sub-contracted to certain activities for the University under this innovation fund.

Looking to the future, RAN aims to earn more contracts and awards from USAID and other donors to continue and grow their fundamental mission. To increase their chances and strengthen their competitiveness when applying for such funds, they continue to expand their network by adding universities located in places where they lack geographic coverage. They currently see themselves as a research and innovation platform that can do international development work across most of Africa, quickly.

DISCUSSION

Dave Cooper, USAID

The case studies selected and presented here are not an exhaustive list of the innovators sampled in the survey; these innovations were chosen because they exemplified themes identified in the surveys that addressed factors where RAN's affiliation with a HEI likely impacted innovation processes. Although RAN accessed experts from different parts of the University, not every innovator needed such individualized assistance. Much of the help innovators needed was also done by RAN staff, who were

chosen based on their business development and community outreach skills, staff that other innovation support hubs could recruit. Moreover, some innovators used their own connections within the University to access expertise, and occasionally, reached out to those contacts directly. These examples illustrate a channel likely operating elsewhere. In Silicon Valley, for example, many original innovators were graduates of Stanford, so while they may not have had a formal relationship with the University, once they began working on their innovations, they must have still known some experts at Stanford with whom they could reach out to for informal assistance when needed.

While this explains why innovation tends to flourish in areas geographically proximate to HEIs, it does not answer the question as to whether hubs located at universities have any (plausible) independent impacts compared to their counterparts in the private, non-profit, or public sectors. The interview with a member of RAN leadership, however, indicated that Makerere University encourages – and rewards – faculty for interdisciplinary research. The interview also revealed that when no connections existed between RAN and an expert who could help with a specific innovation, they used formal University channels to identify one through departmental leadership. These formal channels likely increased the number of innovators who accessed expertise on the margins. To test this formally, one would need to compare the percentage of innovators accessing expertise across different hubs, both based at HEIs and outside HEIs, but qualitative evidence suggests this impact was real. Only one innovator in the sample did not receive a mentor who stated they hoped for one. Every other innovator who mentioned the need or desire for a mentor ended up with a connection, supporting RAN's statement that finding faculty to provide help was straightforward. While several mini-case studies show RAN's assistance was not always needed to make a connection, only one innovator was not matched when desired, suggesting that this formal channel, where no prior relationship exists, did improve the efficiency of matches on the margin. Moreover, several innovators in the survey stated that RAN's help in matching them to a mentor was helpful in furthering their innovation process in response to open-ended questions about RAN's assistance. If all innovators had these connections prior to joining RAN, these statements would be unlikely responses to an unprompted question about general help from RAN. Future research would be needed to unpack this further by collecting data that is able to compare the success rate (or more accurately the failure rate) of innovator access to experts for innovators at a HEI-based innovation hub versus an independent hub, however, the data here are suggestive that the impact is positive.

An additional theme that surfaces from the qualitative work is that many innovators need institutional protections in place to test their innovations. While many of the innovations in the agricultural sector are focused on agriculture output itself – e.g. changes to post-harvest processing generally focus on

things such as spent corn cobs or how to dry a crop using a new, more environmentally friendly technique – many of the other categories focus on and ***must be tested*** on human beings. Most often this is true of the health care innovations, but other innovation types also necessitate human subject testing. For example, the porridge innovation demonstrated a potential risk to end users. Moreover, testing the effectiveness of GBV innovations like the bracelet will eventually require working with sexual assault victims, necessitating strong human subject protections.

As described through many of the case studies presented, the development process for many innovations requires oversight to ensure their piloting does not harm people who help the innovator with testing. Within typical university systems, this falls on the IRB of the relevant departments. As part of the School of Public Health at Makerere University, RAN has access to their IRB and to others at the University. RAN's location at a HEI means that it has easy access to this oversight mechanism. While it is possible for non-University based hubs to create these institutions internally - after all, the survey used here was cleared by one such entity – it may take time and resources to build up the wide variety of expertise needed for this review process. On this front, HEIs have a built-in advantage for implementing innovation activities with a local co-creation component like the one described here.

The next theme that surfaced during the qualitative work is related to the prior theme, but on the scaling side, rather than the product development side of the innovation process. Specifically, innovators within clusters such as the one in Kampala, where informal firms dominate, often create products that do not exist yet. As a result, the Ugandan government has yet to develop regulations for many of the products being developed. Innovators who want to begin the approval process to allow the future sale of their products in Uganda, often get stuck at this regulatory barrier. However, the survey histories provide evidence that in some cases, RAN introduced the innovator directly to regulators to begin discussions over the need for future regulations, though it remained unclear what the final result of these discussions would be at the time of the interviews.

Here RAN's affiliation with Makerere University has been extremely helpful. A subset of innovators facing this obstacle were granted waivers by regulatory agencies, indicating that the innovators can continue to develop - and test - their innovations under the supervision of Makerere University without additional governmental regulations. These waivers essentially substitute Makerere University's oversight for government oversight ***temporarily*** during the development and testing process. With waivers in place, regulators have time to research and learn about the issue or new technology so that regulations might be established when the innovation is ready for scale. By essentially, pre-briefing regulators about

emerging technologies or innovations, the innovators help ensure that the needed regulations will fit their approaches and be approved by the relevant government agency before widespread scale is reached. As of the time of interviews, in a few cases, innovators stated that regulators considered writing new regulations, or clarifying them, but had not yet seen the results of those promises.

It is important to note that these waivers do not eliminate the obstacle - at some point innovations will need regulatory approval. This is especially important for medical devices and similar innovations whose primary customer will be hospitals and clinics, many of which are public entities. However, waivers do allow these two processes to move forward simultaneously, rather than consecutively, and provide a channel for making regulators aware of these issues in advance. These examples also raise an important question regarding Makerere's role as a well-respected HEI in Uganda vis-à-vis other incubation hubs. Specifically, do innovators from other hubs receive waivers as well, or is this limited to Makerere (and other HEIs) as a public institution(s)? While the data here do not provide a clear answer to this, they suggest that Makerere can take on certain government functions (temporarily) that allow the development of innovations to proceed.

It is important to note that this finding was not unique to RAN innovators. A KII with an official from a government research institute that supports several healthcare innovations, despite being a government laboratory, also ran into regulatory obstacles. They stated that government laboratories sometimes lack equipment to test the safety of certain innovations, which can require specific instruments without a broad set of uses. This can mean that some innovations cannot be tested for safety until new budgetary resources become available to procure equipment and that certain innovations, which need a very specific instrument for testing, may be delayed if other instruments can test a larger cross-section of innovations. In other words, government laboratories have to make decisions on what they prioritize in a cost constrained environment. This official went on to say that the laboratory had done testing for a government regulatory agency in the past that lacked certain pieces of equipment, similarly substituting themselves – temporarily – for the relevant regulatory agency much like Makerere does through regulatory waivers during pilot testing (note, this testing was not of RAN innovations). This example further demonstrates that regulatory approval remains a challenging issue that the innovation ecosystem will need to address and overcome. Moreover, Ugandan officials and government Labs have been quite creative in finding temporary solutions that allow innovation to proceed, but ecosystem-level obstacles still require attention if the innovation ecosystem is to continue to grow, develop, and succeed across Uganda.

This suggests that even once regulatory processes are well established, there may still be a considerable backlog of testing for innovations due to a lack of equipment and other budgetary constraints. This government institute official discussed in the previous paragraph had several European research partners, and as a result, submitted a small number of innovations for regulatory approval from the European Union (EU), not Uganda, because the Government of Uganda accepts products approved by many US and EU regulatory authorities. While this path is not available to most innovators, it highlights the need for assistance at the national government level if many innovations are to be scaled. As more RAN innovations mature, issues surrounding regulatory and safety testing will affect more innovators. This finding also highlights the need for future activities that focus on capacity development within the Ugandan government and innovation ecosystem.

Finally, RAN's reputation did help open doors for innovators beyond public sector actors, such as regulators, to other parties. Innovators across health, agriculture, and beyond pointed to instances where their affiliation with RAN, and by extension Makerere, opened doors for them. For example, the innovator who built the agricultural market platform stressed that they would always mention their affiliation with RAN when discussing their platform to potential partners. Their affiliation, they believed, did not mean that an agreement with that potential partner would necessarily work out, but it did provide a signal that their innovation was serious enough for that counterpart to begin discussions. In other words, their affiliation got them the meetings they sought and the opportunity to determine whether that partner was a good fit.

CONCLUSION

RAN's location at Makerere University has helped many of the innovations they support move further along the development process than they might otherwise have outside a HEI. RAN uses formal channels across the University to tap into experts who are just beyond their personal networks, ensuring the innovators have access to expertise they might not otherwise have, absent this formal relationship. While some innovators reach out for help themselves, they are limited by their own networks.

Kate Holt, USAID

In addition to faculty and other experts, Makerere University has several internal institutions that RAN leverages. The most important of these is the IRB, which provides an oversight mechanism to innovators as they test their innovations, while minimizing risks involved with testing. As one looks over the qualitative case studies, they see innovators also used laboratories at Makerere to great effect. In some cases, such as with the porridge example, it allowed the innovator to put themselves on equal footing with a business partner before they entered a legal arrangement. To use a term from economics, their access to the laboratory allowed them to overcome an information asymmetry – which could have led to them making a worse and less safe deal – prior to finalizing that deal.

RAN has also leaned on Makerere to substitute the University's oversight institutions for the Ugandan regulatory institutions, at least temporarily. This has removed obstacles during the development process and facilitated conversations with regulatory agencies early on so regulators were aware of work happening in Uganda that would need to be addressed. As the interviews with ecosystem actors and innovators demonstrate, this is a key area for future capacity building if innovation is to succeed in Uganda more generally.

And finally, innovators gain reputational assets through their association with RAN and Makerere, signaling to other actors in the cluster their innovation is a serious idea that has already been vetted by knowledgeable and trusted experts. Evidence from the case studies suggest that this opened doors for innovators supported by RAN, both in the private and public sectors.

In summary, RAN's location at Makerere has benefited the innovators it supports in various ways. As a higher education institution, Makerere's reservoir of expertise and its reputation within Uganda, both among private and public actors, provided benefits to RAN that they passed onto the innovators they support. As RAN looks to the future, it can continue to leverage Makerere's institutions, expertise, and reputation to attract funding, provide research and innovation services, and expand into new parts of Africa, thus connecting higher education across the continent under one umbrella.

Since this study is a single case of one HEI-based hub, one may wonder whether the conclusions reached here are applicable elsewhere. While further research would be required to definitively answer this, the conclusions and discussion contained herein have identified specific factors that (should) exist at other higher education institutions and support work in innovation. As was recognized, HEIs with professional internal review boards and other regulatory abilities, faculty with a history of publication, strong research capacity, and support to conduct interdisciplinary and non-traditional work (such as mentoring), and impeccable reputations with academic, governmental, and industrial stakeholders should be prime candidates for partnerships with, or the creation of new, innovation hubs. Importantly, these conclusions each name factors that can be tested empirically at other hubs co-located at HEIs.

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ANNEX

SAMPLE DESCRIPTION

Survey respondents were drawn from RAN's list of funded and non-funded innovators. The funded list totaled 99 innovations and the non-funded list included 144 innovators. The non-funded list, however, included five innovations from other countries (Ethiopia, Kenya, and South Africa). These innovations were excluded from this analysis because the academic literature's focus on the positive effects of proximity to other innovators in the cluster suggests few, if any, benefits for them from RAN or the Makerere University beyond conversations or information they may have gotten from participating in those discrete events. The final list of non-funded innovations then, included 139 innovations that were geographically located in Uganda. In total, RAN cluster consists of 230 innovations.

From these two lists, the research sampled 30 funded innovations and 60 non-funded innovations. The decision to sample approximately twice as many non-funded innovations was made because both the researchers and RAN anticipated higher response rates from funded innovators, especially innovators whose awards remained open as they remained in regular contact with RAN staff. Moreover, we expected more innovators in the non-funded group to have moved onto other pursuits, many of which would be outside Kampala. From this group of 90, 46 innovator surveys were completed. Funded innovators finished 24 (or 75 percent of funded innovators) and non-funded innovators completed 22 surveys (or 38 percent of the non-funded innovators).

Of the non-responses, we can analyze who was sampled but did not participate in the survey. For the funded innovators, only one of the 6 non-responses were due to the respondent declining the interview request. The other five were all outside Uganda during the time interviews were conducted in Kampala. However, all funded innovators were contacted by phone or email and we received a response indicating their preference for participation.

As expected, the non-funded innovators were less likely to agree to take the survey. Five of the non-responses are because the innovator did not have time or was not interested in taking part in the research, two of the non-responses were in rural areas during survey implementation making them temporarily unreachable, one had agreed to be interviewed but a large storm led them to cancel on the

last day of interviews. The remaining 28 did not respond to attempts to contact them via email and/or phone. Although RAN provides services to non-funded innovators, it does not track innovators who only attend workshops and other events with the same level of effort it does those who receive funds from them.

APPENDIX TABLE 2: INNOVATIONS BY CATEGORY

TABLE 2 INNOVATIONS BY RECODED CATEGORY DIFFERENCE OF PROPORTIONS TESTS				
INNOVATION TYPE	TOTAL SAMPLE	FUNDED	NON-FUNDED	T-STATISTIC (P-VALUE)
Agriculture	0.48	0.41	0.54	0.89
	(0.07)	(0.11)	(0.10)	(0.38)
Healthcare	0.26	0.32	0.21	-0.84
	(0.06)	(0.10)	(0.08)	(0.41)
GBV	0.09	0.14	0.04	-1.13
	(0.04)	(0.07)	(0.04)	(0.26)
Other	0.13	0.14	0.13	-0.11
	(0.05)	(0.07)	(0.07)	(0.91)
N	46	22	24	N/A

Note: Standard errors of proportions in parenthesis. P-value < 0.05 denoted with **. P-value < 0.10 denoted with *. Columns may not perfectly add up to 1 due to rounding.

APPENDIX TABLE 3: INNOVATIONS BY CATEGORY

		TABLE 3 INNOVATIONS BY RECODED CATEGORY DIFFERENCE OF PROPORTIONS TESTS USING ALTERNATIVE DEFINITION OF WHO'S FUNDED		
INNOVATION TYPE	TOTAL SAMPLE	FUNDED (ALTERNATIVE)	NON-FUNDED (ALTERNATIVE)	T-STATISTIC (P-VALUE)
Agriculture	0.48 (0.07)	0.43 (0.10)	0.56 (0.12)	0.83 (0.41)
Healthcare	0.30 (0.07)	0.29 (0.09)	0.33 (0.11)	0.34 (0.74)
GBV	0.09 (0.04)	0.14 (0.07)	0.0 (0.0)	-1.69* (0.097)
Other	0.13 (0.05)	0.11 (0.06)	0.17 (0.09)	0.57 (0.57)
N	46	28	18	N/A

Note: Standard errors of proportions in parenthesis. P-value < 0.05 denoted with **. P-value < 0.10 denoted with *. Columns may not perfectly add up to 1 due to rounding.

COPY OF QUESTIONNAIRE

RAN Innovation Cluster Survey

FIRST: Read Makerere Consent

Survey Number [ ] [ ]
Date of Survey [ ] [ ] / [ ] [ ] / [ ] [ ]

CHECK POINT: Thank you for your participation. First, I'd like to collect some demographic information about you, the innovator.

A.1	Which gender do you identify with?	1. Male 2. Female 3. Other: _____	
A.2	How old are you? (complete years or date of birth so that you compute yourself?)	_____	
A.3	Are you currently enrolled in school?	1. Yes 2. No	
A.4	If yes, what class are you working on?	_____	
.A.5	How many years of school have you completed?	_____ years	
A.6	Did you graduate from high school?	1. Yes 2. No	
A.7	Did you graduate with a bachelor's degree?	1. Yes 2. No	→ Skip
A.8	If yes, what field or department?	_____	
A.9	Did you graduate with a master's degree?	1. Yes 2. No	→ Skip
A.10	If yes, what field or department?	_____	

A.11	Did you graduate with a PhD or other advanced degree?	1. Yes 2. No	→ Skip
A.12	If yes, what field or department?	_____	
A.13	What is your marital status?	1. Single 2. Married 3. Divorced 4. Widowed 5. Other: _____	
A.14	What is your ethnicity?	Primary: _____ Secondary: _____	
A.15	What is the primary language you speak in your home?	_____	
A.16	**If applicable**: what is the secondary language you speak in your home?	_____	
A.17	What is your religion?	_____	

Second, I'd like to ask you about your current job and finances to understand how much of your income and time are spent on innovation versus other work you might do.

B.1	What is your primary source of income?	_____	
B.2	How much money do you earn from this income source?	_____ per _____	
B.3	How many hours per week do you take part in this activity?	_____	
B.4	**If applicable**, what is your secondary source of income?	_____	
B.5	How much money do you earn from this income source?	_____ per _____	
B.6	How many hours per week do you take part in this activity?	_____	
B.7	**If applicable**, what is your third source of income?	_____	
B.8	How much money do you earn from this income source?	_____ per _____	
B.9	How many hours per week do you take part in this activity?	_____	
B.10	Are you an innovator?	1. Yes 2. No	→ Skip C

Next, I'd like to talk about your innovation directly.

C.1	Please describe your innovation		
C.2	Please describe why your innovation is better than current alternatives:		
C.3	For consumers who buy your product, how many alternative products exist they could buy instead? Include alternatives that are of inferior quality.	_____	
C.4	Who are your target customers?	_____	
C.5	Where are they located? Include distance to closest customers if known.	_____	

C.6	How long ago did you first think of your innovation?	_____	
C.7	How many years ago did you create the first prototype?	_____	
C.8	How many times have you made changes to your innovation? Please include changes that did not work out.	_____	
C.9	Please provide a history of these changes, beginning with your first prototype. For each change please explain • why you made the change • who you discussed the change with prior making it - was this person a potential customer, another innovator, or someone else? **Do not record name(s) on survey** • what design issues you had to solve • whether the change made the innovation better		

C.10	**STOP:** Of the people you've mentioned while describing the history of your innovation, would you provide me with contact information for them so I can conduct an interview with them too? If yes, I will NOT record their names on your survey. I will put them on a separate list, which will be destroyed once this project is complete. 1. Yes 2. No **If yes, record contact information on RAN Snowball Innovator List. If no, move onto next question.**		
C.11	Why did your innovation evolve from your initial vision? Please explain why you think it ultimately took this trajectory.		
C.12	How much monetary assistance did you receive from the ResilientAfrica Network (RAN)?	_____	

C.13	How much money have you borrowed to develop your innovation?	_____	0 → Skip C. 17
C.14	How long ago did you borrow this money?	_____	
C.15	How much have you paid back as of today?	_____	
C.16	Who did you borrow this money from?	_____	
C.17	Please list all of the assistance you have received directly from RAN, ***excluding money***, to help you develop your innovation.		
C.18	Please list all of the assistance you have received from people you have met through RAN, ***excluding money***, to help you develop your innovation.		
C.19	How many times per week/month do you discuss your innovation with someone you met at a RAN event or activity?	_____	

STOP: Section D to be filled ONLY by respondents identified through snowball. Otherwise skip section.

Next, I'd like to talk about your discussions with this innovation directly.

D.1	Are you familiar with (prefill description of innovation from previous survey)?	1. Yes 2. No	
D.2	How do you know the innovator?	_____	
D.3	Are you a target customer for this innovation?	1. Yes 2. No	→ Skip
D.4	If yes, how does this innovation compare to alternatives you currently use?		
D.5	For this innovation, how many alternative products exist that you could buy instead? Include alternatives that are of inferior quality.	_____	
D.6	How long ago did you first find out about this innovation?	_____	
D.7	Have you provided finance to the innovation to develop their innovation?	1. Yes 2. No How much: _____	→ Skip
D.8	How much has the innovator paid back?	_____	
D.9	How long ago did the innovator borrow this money?	_____	
D.10	Please describe your conversations with the innovator about the innovation. In particular, what advice have you provided to the innovator: • To make the innovation more desirable for purchase • To improve the design of the innovation		

	• To help the innovator problem solve an issue during the development of the innovation		
D.11	How many times per week/month/year do you discuss the innovation with the innovator?	_____	

Finally, I'd like to ask you about environmental factors in Uganda that help or hinder innovation from your perspective.

E.1	How would you change the laws or policy environment in Uganda to make it easier for innovations like your to come profitable?	
E.2	What have actions have you taken to ensure this law or policy is changed?	

E.3	Who did you take this action with? Where did you plan this action collectively?	
E.4	What was the result? If no result yet, what is the current status of this action toward changing this law or policy?	

F.1	Finally, are there any other things you think I should know about your innovation or innovation in Uganda more generally?	

Thank you for your time. As I mentioned at the beginning of this interview, if you have further questions about the research, you can ask me now or contact me at:

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