



Soybean breeder Dr. Nicholas Denwar points out varietal differences to Ghanaian farmers at SARI's 2018 Soybean Kickoff Event. Although SARI's researchers are highly trained and do good work, they have been constrained in their ability to communicate directly with the Ghanaian public due to shortcomings in their institutions ICT capabilities. Picture: Paul Hixson

Critical need for improved ICT connectivity at Universities

By Paul Hixson and Tracy Smith

One of Sub-Saharan Africa's (SSA) greatest under-recognized (and under-resourced) development challenges is how to rapidly extend high-speed internet connectivity to the region's universities and National Agricultural Research System (NARS) institutions. However, relief is on the horizon with the formation of new National Research Education Networks (NRENs) in many countries across SSA. That's the conclusion from a veteran team of ICT researchers from the University of Illinois working on an ICT Connectivity & Utilization project as part of the USAID-funded Soybean Innovation Lab (SIL).

When one reads the economic development plans of most SSA nations, a common theme quickly emerges that in order for that country to advance their economy and successfully meet the pressing food security challenges on the horizon their leaders will have to fully leverage the knowledge and skills of researchers at their agricultural universities and NARS institutions. That

makes sense because that's precisely why the national ag research systems and universities were established in the first place. That's also why governments and donor agencies have invested heavily for generations in building up the physical infrastructure at these institutions and in sending Africa's best and brightest minds abroad to earn advanced academic degrees at some of the finest research institutions in Europe, Asia, and the Americas.

Over that same period, African graduate students attending global research institutions witnessed the radical transformation driven by rapid advances in information technology that changed nearly EVERYTHING about how modern research is now conducted. Changes in ICT have totally transformed how ag researchers and educators conduct their work, and even how they interact with peers, both locally and globally. The authors of this paper have closely watched these developments over the course of their careers at the University of Illinois where they have seen agricultural researchers' pencil and paper

toolkits be replaced by computer and smartphone toolkits – and those devices offer always-on connections that are dependable, affordable, and fast. Calculators gave way to spreadsheets and databases; paper memos declined while email and text messages skyrocketed. Colleagues today are only a quick video call away, even if they are on another continent. And, the main repositories of research data are now stored primarily on secure servers with remote connectivity and 24/7 access. Today, super-computing clusters routinely model how changes in agricultural production will impact both the economy and the environment. This changed workplace, made possible by the ease and speed by which tasks can now be completed, is dependent on a fully operational 24/7 ICT infrastructure, which also defines our mantra: "ICT has become the new oxygen for today's ag researcher." Dependable, smoothly operating ICT resources and services are the oxygen for today's ag researchers and educators.

All too often, recently graduated African scholars return home to essentially an “oxygen deprived” environment. This mission-critical problem, recognized early on by the SIL’s research leaders, manifested as work with 4 SSA countries in 2013 expanded to 18 in 2018. Although the NARS institutions and Ag Universities in SSA had good facilities and highly talented faculty/staff, collaborations with the SIL’s US ag researchers were impeded due to inadequate ICT infrastructure and services. Routine communications channels between US and SSA researcher collaborators were severely restricted with bandwidth-intensive data transfers requiring the more dependable physical media and courier services. SSA researchers were disadvantaged in that advanced data gathering and analysis techniques had to be led by the US-based researchers due to inadequate local IT infrastructure. Perhaps worst of all, those newly returning researchers with an advanced degree from abroad found themselves unable to contribute at a level that their professional training had prepared them for.

In late 2018, to identify and overcome the root ICT issues, SIL created a new area of research and invited Paul Hixson, a 42 year IT leader at the University of Illinois in the College of Agriculture, Consumer & Environmental Sciences and a 3 year history as campus CIO at Illinois, to lead this research. Hixson solicited help from Tracy Smith, current deputy CIO for Innovation at Illinois, to join him in this effort. Hixson and Smith worked with colleagues at the National Startup Resource Center (NSRC) at the University of Oregon to develop a standardized assessment tool, the ICT Health CheckUp, that could provide quantifiable data to measure the main aspects of an institution’s ICT support system and determine how well it meets the needs of today’s agricultural researchers. This assessment tool measures four essential components of ICT support that must be present to empower ag researchers to do their important work.

- Connectivity
- Physical infrastructure
- Intranet services
- ICT Professional Staff



A view of SARI’s “server room”, during Hixson’s first visit to Nyankpala, Ghana in October 2018. At that time, SARI lacked adequate bandwidth for their researchers and their server equipment was located in a corner of the IT manager’s office which lacked constant climate control, was open to non-IT staff access, and had a number of wiring problems.

Initial field work, conducted at the Savanna Agricultural Research Institute (SARI) in Nyankpala, Ghana, revealed that poor ICT connectivity resulted in researchers circumventing the institution’s network and relying on personal cell phone contracts for cellular connectivity to the internet. Using the ICT Health CheckUp, Hixson was able to identify an emerging theme: NARS institutions typically rely too heavily on commercial telecom providers who are focused on selling only low-bandwidth, over-priced commodity services rather than seeking out their country’s National Research Education Network (NREN) that is a member-owned cooperative organization focused solely on meeting the unique connectivity needs of researchers and educators. <https://ajfand.net/Volume20/No5/Goldsmith19385.pdf>

Although initially a general lack of awareness existed between SARI senior staff and the new NREN, GARNET, within 3 years, Hixson was able to connect SARI and GARNET resulting in a 93% reduction of internet service cost with a capacity expansion of 75x. For a fuller report from SARI’s researchers on this success story, <https://bit.ly/3vvROuq>

This GARNET/SARI story is far from unique. As member-directed cooperatives, NRENs are designed to provide low-cost internet service to member institutions while fostering a human network of member IT professionals with similar support needs and a willingness to collaborate on common regional issues. NRENs offer additional auxiliary services that enable institutions to quickly incorporate new ICT services for their researchers and educators. Beginning in the 1980’s, the development of NRENs in the US, Europe, and Asia proved to be a key factor in driving the sort of dramatic ICT cost savings and technology gains that Hixson and Smith have long witnessed at their University and other peer major research institutions around the world. A key differentiator for member-owned NRENs is that the focus can remain on providing research and education-focused services without the overhead need of making a profit for shareholders, as is true with a commercial telecom. The good news throughout SSA is that new NRENs have emerged across the continent

in recent years, with even more in the planning stages. In any country that has an operating NREN, member institutions can commonly expect lower-cost connectivity with a wide range of auxiliary services commonly not offered by private sector telecoms, which have focused almost exclusively on developing the cellular market.

For example, the Zambian NREN, ZAMREN, experienced phenomenal growth over its inaugural 7 years of existence growing from 3 member institutions in 2007 to 126 members in 2019, and through strategic purchasing of excess capacity from fiber owners, was able to also increase bandwidth by over 16X, while lowering the cost per Mbps by 4X for all members. Delivering higher customer value demonstrates the power of an NREN. Additionally, as the Covid-19 pandemic put extra pressures on all educational institutions to go online and deliver “virtual” services, ZAMREN helped member institutions gain familiarity with new online program delivery platforms, like Moodle and Zoom.

Just prior to Covid-19-imposed travel restrictions, the ICT Connectivity team visited Malawi and consulted with leaders of the emerging NREN in Malawi, MAREN. While there Hixson was able to collect ICT measurements at the main campus of LUANAR (Bunda College) and at the NRC campus. Results revealed inadequate services delivered by a private telecom provider. Since that time, we have learned that MAREN is now provisioning new fiber-based services at both locations.

Through our work on the ICT Connectivity project, the SIL team has been fortunate to form strong partnerships with many ICT leaders in SSA who are actively working with these innovative NREN organizations. In June 2020, we joined our NREN colleagues in team-teaching a webinar on the topic of “ICT Connectivity: The Oxygen of Today’s Agricultural Researcher”. We had 70 attendees from 23 countries online, and a recording of that webinar can be viewed today at: <https://www.youtube.com/watch?v=SQ4fCntT2Lw&t=26s>



ZAMREN's server room

In conclusion, we make 3 recommendations:

1. If you are associated with a SSA university or NARS institution, we strongly recommend you identify and connect with your local NREN to learn of connectivity availability for your institution. For NRENs in East or South African regions, reference: <https://ubuntunet.net> For NRENs in West or Central African regions, reference: <https://www.wacren.net>
2. We are currently in the final stages of converting the ICT Health CheckUp to a more user-friendly, online, web-based tool. We will provide information on how to access the updated tool upon completion.
3. Looking to the future, we would ask the international donor community to invest more directly in helping NRENs build their own fiber network. NRENs in SSA are currently disadvantaged in competing with large cellular service companies when purchasing sufficient bandwidth to pass on to their member institutions. As Steven Song, a Google Fellow with an appointment at NSRC recently stated, “there is a growing frustration

with the underutilization of national fibre backbones. Fibre networks are the deep-water ports of network infrastructure, yet they are still treated as commodities to maximize return on, rather than infrastructure which can boost entire economies.” <https://manypossibilities.net/2021/02/africa-telecoms-infrastructure-in-2020/>

Our hope is that the international donor community will realize that if they were simply to make major “bootstrap” investments in helping build an NREN-owned fiber infrastructure within each country that the NRENs could then operate at low cost for their member institutions, by that action alone, they would unleash the tremendous research and development potential that is currently locked up inside those institutions — and which is so desperately needed by the people living there. Perhaps it’s time for a pilot research project to measure the many benefits that such a public investment might make for all SSA.