Rwanda: Success Stories

Aflatoxin research in Rwanda brings rewards and challenges

1Kizito Nishimwe, right, accepts $15,000 check from Josefa Leonel Correa Sacko, Commissioner for Rural Economy and Agriculture, African Union, to continue research on aflatoxins.

Holding an oversized $15,000 check, Kizito Nishimwe was all smiles as he accepted an award in October 2018 from the Partnership for Aflatoxin Control in Africa (PACA) during the third PACA Partnership Platform Meeting held in Dakar, Senegal in October. The award will fund a new line of research as part of his dissertation at Iowa State University, and it validates the year he spent as a co-principal investigator on a scientific project in Rwanda funded by the Feed the Future Innovation Lab for Livestock Systems.

The need to control mycotoxins in agricultural products is a growing concern. Aflatoxins (a class of mycotoxins) are toxic compounds produced by fungi that contaminate crops and animal feeds, particularly under hot and humid conditions. The toxins can be passed from the diet of cows to their milk and they have been linked to stunting and liver cancer if ingested through food items or passed unknowingly from pregnant and nursing mothers to their children.

The project with Nishimwe detected high levels of mycotoxins, specifically aflatoxins, in animal feeds. "Our results are not different from those so far reported in other African countries," said Nishimwe. "Mycotoxins are a challenge in Africa and need appropriate mitigations for not only protecting human health and animal health but also promoting African trade with the rest of the world." Potential exports of crops and food products may falter if they are contaminated.

The Rwanda-Iowa Connection

Dr. Maier giving a seminar at the University of Rwanda's School of Food Science and Technology in December 2016.

A strong team of researchers guide the project, "Assessment and Mitigation of Aflatoxin and Fumonisin Contamination in Animal Feeds in Rwanda," which started in December 2016 and is wrapping up in 2018. The project was conducted in collaboration with Bioscience in Eastern and Central Africa – International Livestock Research Institute (BecA-ILRI) and the University of Rwanda. Its principal investigator, Dr. Dirk E. Maier from Iowa State University, is a post-harvest engineer and mentor of Nishimwe. Nishimwe has dual roles as a graduate research associate at ISU and a lecturer at the University of Rwanda, his home country. He has a fellowship from the USAID Borlaug Higher Education for Agricultural Research and Development (BHEARD) program. The project's second co-PI is Iowa State University's Dr. Erin Bowers.

Detection of aflatoxins is one step, and educating people about them is another. The project developed an aflatoxin analysis lab with a more affordable method for measuring aflatoxins in feeds than the standard method.

It surveyed farmers, feed processors and vendors for their knowledge about aflatoxin risk for human and animal health. Notably, more than 9 out of 10 study participants lacked awareness of mycotoxins. The project created and began distributing an educational poster and rack card in the local Kinyarwanda language. "We also recommend that Rwanda implement a broader mycotoxin awareness campaign and educate farmers on how to prevent contamination of their feeds," said Maier.

More on Methods

The project tested feed samples after establishing a mycotoxin laboratory at the University of Rwanda. Analyses were performed using Enzyme-Linked Immunosorbent Assay (ELISA), which was cross-validated against the gold standard method by the lab of Biosciences Eastern and Central Africa – International Livestock Research Institute (BecA-ILRI) in Kenya.

To facilitate future research, the project acquired equipment to expand the mycotoxin analysis lab at the University of Rwanda. The new ELISA-based analytical method will cost nearly 90% less for aflatoxin analysis than the gold standard method, and the staff of the University of Rwanda mycotoxin lab are well prepared due to training provided by the project.

Dr. Bowers (standing), Nishimwe and students at University of Rwanda analyzing feeds and feed ingredient samples for aflatoxin. (credit: K. Nishimwe)

Nishimwe's award provides seed money for new research on assessing the efficacy of cold plasma in degrading aflatoxins. The technique, using ionized gas, shows promise for sterilizing food. His winning proposal was selected from among more than 120 proposals from 20 African countries.

Student dairy scientist in Rwanda shares her story and potential

About the author: Alice Ingabire plans to graduate in November 2018 with a master's degree in animal production at the University of Rwanda. Her thesis title is: The On-Farm Factors Affecting the Quality of Raw Milk and Quality Control of Raw Bulk Milk from Farms to Milk Collection Centers Along the Dairy Chain in Rwanda

Students involved in research projects receive more than financial support for their degrees from the Feed the Future Innovation Lab for Livestock Systems. I am being mentored in writing proposals and protocols, data collection and analysis, statistics and biosafety. I plan to graduate in November 2018 with a master's degree in animal production from the University of Rwanda, and I am one of the two graduate students working on the mastitis project led by Jean Baptiste Ndahetuye.

I helped to collect baseline data from Milk Collection Centers (MCCs) across Rwanda to identify gaps that lead to decreased milk quality and safety in the value chain. Administering questionnaires on milk handling practices to nearly 400 farmers in 8 MCCs, I experienced firsthand the challenges faced by dairy farmers. I also analyzed milk for cell counts, antimicrobial residues, and total bacteria and coliforms as hygiene indicators.

Alice Ingabire, right, with mentor Dr. Ndahetuye, at the June 2018 agricultural show in Rwanda.

The project found that total bacterial counts increased from farm to their respective MCC, which indicates multiplication during transport due to various factors, including the use of plastic containers in milk delivery and up to 4 hours in transportation without refrigeration.

Total coliforms did not change significantly. High levels of somatic cell counts at some farms and MCCs are indicative of problems with mastitis. Additionally, the project found 5 cases of antimicrobial residues out of 372 tested milk samples. Four out of the five cases of antimicrobial residues were mainly found in the region with high rates of subclinical mastitis, which suggest the use of antimicrobials in treating mastitis cases, which may lead to antibiotic residues in milk if a proper withdrawal period is not used at the farm level.

After thoroughly understanding gaps in the milk value chain, I was involved in developing training materials and participated in educating the 226 attendees of workshops on "Training farmers in best practices for good udder health and milk quality and safety," which were held at eight MCCs across Rwanda. By teaching, I increased my confidence in the areas of milk safety, animal disease management and human nutrition. The trained farmers have reported greater awareness, for example, of hygienic challenges associated with plastic milk containers in comparison with stainless steel cans, and linkages of subclinical mastitis to milk quality, as well as human health.

These findings and other challenges are inspiring me to improve critical analysis and evaluation of the milk dairy chain in Rwanda for needed improvement. Through active participating in the project, I hope to exercise my skills and reach my highest professional potential as a female, young scientist in Rwanda.

A Shout Out for Milk

Dr. Emily Ouma, International Livestock Research Institute

It turned out better than they planned. Instead of quietly spreading nutrition messages from household to household, community advocates amplified their voices through megaphones to reach the masses gathered at markets in Rwanda.

"*Gabura Amata Mubyeyi*," they said, which translated from Kinyarwanda means "Parents, Give Milk." The advocates also shared other messages targeted at pregnant and lactating women and their children. In the end, instead of reaching a few thousand people as planned, this project shared information with 10,950 people.

This change of course shows that research-for-development projects can apply principles of adaptive management. The project, Enhancing quality and consumption of milk for improved income and nutrition in Rwanda, was implemented between early 2017 to September 2020. Its final months coincided with the COVID-19 pandemic.

That crisis was not the only external force that encouraged the project's team to adapt. In 2019, the Government of Rwanda, its National Early Childhood Development Program (now called National Child Development Agency), and USAID Rwanda Mission, recognized the project's potential and wanted to expand its reach to ensure all participants received the important nutritional messaging. But this request conflicted with the project's experimental trial that required a control group for comparison with a group receiving messaging ("*Gabura Amata*

Mubyeyi") on nutrition, particularly the importance of milk in the diet (using an approach known as a cluster-randomized longitudinal cohort study).

Finding a way forward in 2020, the project team created a delayed intervention, funded by USAID Rwanda Mission. They completed the original study and added an intervention period to ensure those in control households also received the important nutrition messages of *Gabura Amata Mubyeyi*.

Social and Behavior Change Communication

The original social experiment, called a social and behavior change communication intervention, intended to assess if information-sharing would increase the consumption of animal-source foods, namely milk, by mothers and their children. A sizeable team was assembled by Dr. Emily Ouma from the International Livestock Research Institute, the principal investigator of the project, and by primary collaborators from RTI International, University of Rwanda, and TechnoServe. The company Three Stones International supported implementation.

The study collected data in two regions from 652 households representing three groups: the control group, those with a cow from the government's Girinka ("One cow per poor family") program, and those in the Girinka program who also received the nutrition messaging intervention focused on milk consumption. All households were required to have a child who was 12 to 29 months of age.

To reach the large number of households targeted, community health workers (CHW) from the government were trained and supplied with counseling cards and other materials about nutrition. They conducted community events and household visits from February through September 2019. This data was compared to baseline data collected in 2018. In addition, a master's student in gender studies at the University of Rwanda, Agnes Uwera, interviewed 60 people to collect qualitative endline data from July to August 2020.

What did the study find? The data showed that children in Girinka households consumed milk more often than those without a Girinka cow, but many children in Girinka households still did not consume milk daily. For Girinka households, the social and behavior change communication intervention on nutrition messaging increased mothers' knowledge and children's frequency of weekly milk intake.

Two More Components

In addition to this communication intervention, the research project conducted two other projects on capacity development of dairy cooperatives and on the supply of high-quality milk. It documented gains in performance of the dairy cooperatives and found that consumers were willing to pay price premiums for pasteurized milk.

The project gained valuable experience through the addition of the "light touch" delayed intervention, and it has recommended scaling it up to other districts in Rwanda. Moreover, Dr. Ouma was funded by our Innovation Lab to conduct a follow-on project from 2020 to 2021 called Engaging men in supporting maternal and child consumption of milk and other animal source foods in Rwanda.

Engaging Men Supports Nutrition Improvements in Rwanda

Families were observed providing home-prepared milk to children in the Nyabihu District of Rwanda in October 2021 (credit: J.C. Bizimana).

Changing behavior within a relatively short timeframe is challenging, but one research study in Rwanda found that involving fathers was helpful for changing their behavior in support of improving the nutrition of their children. After the study's intervention, children significantly increased their weekly consumption of milk and other animal-source foods. The study also found that fathers significantly increased their knowledge of child nutrition and that they appreciated learning within settings specific to men. The research, funded by USAID through the Feed the Future Innovation Lab for Livestock Systems, was completed in Rwanda in December 2021, and findings are still being analyzed. Initial results are promising as outlined above.

The Process

This project targeting men followed the success of a similar project by the same principal investigator, Emily Ouma, from the International Livestock Research Institute (ILRI). That previous project focused on mothers, children, and dairy cooperatives, and it showed that properly targeted behaviour-change-messaging targeted at women can increase milk consumption by children. It also raised many questions about the roles of Rwanda's men in raising healthy children (see article and photo essay from CGIAR, Milk and animal source foods can help turn the tide on malnutrition for children in Rwanda).

Often, men are essentially ignored during campaigns to improve the nutrition of children. This study attempted to address that gap and assess the role of fathers and men in relation to food choices within the household. To begin, a formative assessment with 48 key informants helped the researchers define gender norms and roles and to categorize knowledge levels about nutrition. The researchers also selected a small group of "model fathers" who could become guides during the project's intervention.

As the planned intervention took place from June to October 2021, the ensuing COVID-19 pandemic limited in-person interactions. Even so, fathers wearing masks gathered at open air venues to learn about best practices for

feeding infants and young children. Fulgence Ntakirutimana was one of the model fathers who taught other fathers at in-person workshops. He reflected on the experience: "I encourage other men to feed pregnant and lactating women and children a balanced diet. The old mindset needs to change. You might think only a wife should care for children. You should understand that, as a husband, you also have a role in caring for the children."

The men not only listened to this advice, but they also acted upon it.

An instructor called a "model father" teaches a group of men about changing behavior to improve household nutrition. (credit: M. Schreiner)

Did They Remember?

Follow-up surveys with workshop participants found that knowledge increased significantly, for example, about when to provide children with cow's milk. Joint decision making between of mothers and fathers about feeding home-produced milk to children also increased. More than 95% of fathers who participated in community meetings or received text messages about milk recalled the project's three key messages about giving animal-source foods to children. Children in their households became more likely to consume milk, eggs, or meat at least twice a week.

Continuing the Work on Gender

One output from this project is a facilitator's guide published by ILRI: Engaging men in supporting maternal and child consumption of milk and other animal source foods in Rwanda. It provides a template for a three-day workshop.

Other research results have been submitted to peer-reviewed journals. These articles will complement the previous project's two journal articles, blogs, and other outreach. Together, the two projects led by Dr. Ouma provide considerable insight into family-based nutrition education that engages both women and men.

Improved Management and Feeding Increase Access to Dairy Products in Rwanda

Milk remains one of the most important sources of nutrient-dense animal source food in Rwanda, and many other Feed the Future countries. Indeed, the government of Rwanda's Girinka program recognizes the critical importance of milk in the diet of vulnerable populations by encouraging the distribution of cattle to low-income families. However, limitations of feed availability and management training hamper productivity. Mastitis, or udder infection, is a challenge in many settings, as it reduces yield and adversely affects milk quality.

Milk collection Center in Rwanda (Photo credit: F. Riaño)

Between 2015 and 2020 (Phase I), Feed the Future Innovation Lab for Livestock Systems affiliated researchers at the University of Florida (UF) partnered with the Swedish Agricultural University and the University of Rwanda (UR) to support the training of Jean Baptiste Ndahetuye as he completed his PhD studying solutions to subclinical mastitis in the Rwanda dairy context. Driven by the efforts of the Innovation Lab's Management Entity this information was used to develop a Rwanda Dairy Farm Assessment and Advisory Tool (RDFAAT) to evaluate and train farmers on methods to improve cow health and productivity, while simultaneously giving tips for better outcomes.

In 2018, in collaboration with the University of Rwanda, the Rwanda Agriculture and Animal Resources Development Board (RAB), and dairy cooperatives, UR and UF researchers trained extension officers and cooperative personnel on the tool and disseminated the tool for field application. In parallel, on the demand side, a project led by Dr. Emily Ouma of the International Livestock Research Institute (ILRI) focused on educating consumers on the nutritional advantages of milk consumption, especially for children under two years of age. It also encouraged producers to hold some milk back from the market for home consumption to improve the nutrition of farm families. That project team also worked with dairy cooperatives to strengthen their capacity and be more commercially oriented while safeguarding milk quality and improving incomes.

In Phase II (2020-2025), these efforts on dairy industry capacity building were leveraged and expanded. A ration balancing tool was linked to the RDFAAT to strengthen knowledge of cow nutrition to support greater productivity. We also evaluated the RDFAAT user satisfaction through direct surveys of those previously trained on the tool, which revealed a positive attitude toward DFAAT and the ration balancing tool but limited penetration into extension programming because access to computer hardware was limited, and the tool was spreadsheet-based. Working with another USAID initiative, the LASER PULSE project under Dr. Kizito Nishimwe at UR, we improved the tools and developed an app for smartphone usage called Zirakamwa, which is available for download from Google Play Store in English or Kinyarwanda thereby significantly increasing access to the tools.

Lessons in Technology Adoption: The Zirakamwa App and Dairy Development in Rwanda

Technology development and adoption do not happen overnight! Let us take you on the journey of the Zirakamwa mobile app in Rwanda. Over the years, the Feed the Future Innovation Lab for Livestock Systems supported several projects to enhance Rwanda's dairy value chain. Back in 2018, the Lab developed the Rwanda Dairy Farm Assessment and Advisory Tool in collaboration with Dr. Jean Baptiste Ndahetuye, who at the time worked with the University of Rwanda. This tool was a Microsoft Excel spreadsheet set up to assess and record dairy farm facilities and practices and subsequently provide comprehensive advice on what needs to be improved to increase the productivity and profitability of the operation. Various components of dairy production are considered and each component has specific factors that need to be evaluated, as depicted in Figure 1 below.

Component	Housing	Milking Routine	Milk handling	Mastitis	Cow Management	Record Keeping	Nutrition
Factors to evaluate	Floor structure	General	Collection, storage, and transportation	Control of contagious mastitis	Rearing heifers	All dairy cattle on	General
	Feed and water areas	Hygiene	Storing milk at the farm	Control of environmental mastitis	Management of dry cow	Breeding	Calf nutrition
	Cow shed		Transportation of the milk to the selling point	Diagnosing mastitis	Management of lactating cows	Calving	Heifer nutrition
	Manure disposal		Hygiene & Disease	Treating sub-clinical mastitis	Management of pregnant cow	Milk production/keeping / sells /consumption	Lactating cow nutrition
				Treating clinical mastitis		Origin and use of all inputs	
						Vet visits	

Figure 1: The seven components of the Rwanda Dairy Farm Assessment and Advisory Tool, along with the factors that need to be evaluated for each.

The tool was aimed at professional advisors such as veterinarians, extension agents, or dairy company technicians during farm visits. Once the observations made on a specific farm are entered into the tool, a graphic is generated that can then be used to explain to the farmer how facilities and practices can be improved (de Vries et al., 2020). The results can also be recorded and used for monitoring purposes, and changes in productivity can be tracked over time.

Once this Excel-based tool was ready, researchers presented it to different audience groups from different geographical areas of Rwanda, including farmers' cooperative representatives, milk collection center managers, private and government practicing veterinarians, and University of Rwanda faculty on several occasions. Two training rounds were conducted for 42 (various stakeholders) in 2018 and 51 (mostly veterinary students) in 2020.

Identifying barriers to adoption

In 2022, LSIL conducted a qualitative evaluation of trainees' experiences and future use of the tool (Riaño Jiménez, 2023). As it turned out, the tool gained little traction due to advisors not having laptops, and if they did, the dependency on electricity (to keep laptops charged) and lack of reliable internet access limited its usefulness during farm visits. Often neither printer nor paper was available to print the resulting graphic. Survey participants indicated that a mobile app version would be a more useful tool since smartphones are more popular than laptops and widely accessible. This conversion to an app was subsequently implemented as part of the USAID-funded

LASER PULSE (https://laserpulse.org) "Technology Tools for Building Resilience of Dairy Farms and Improving Dairy Production in Rwanda" project that faculty from the Livestock Systems Innovation Lab contributed to, University of Rwanda researcher Dr. Kizito Nishimwe was the Principal Investigator for this project. Thus, based on the evaluation findings and building on other LSIL work, the tool was converted into a mobile phone application, and a feed ration balancing component was added to the application. The app, Zirakamwa, is now available from Google Play Store: Zirakamwa - Android Apps on Google Play.

More training… and what's next?

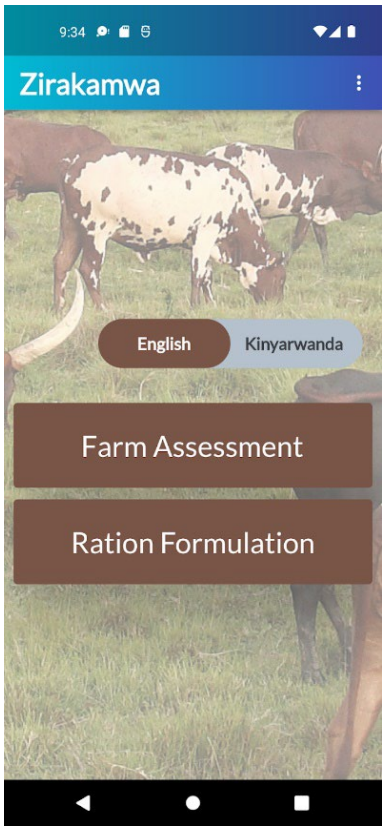

Figure 2: Zirakamwa app on Google Play

Following the evaluation and upon request of the Rwanda Agriculture and Animal Resources Development Board (RAB), another Training of Trainers program was conducted in October 2023. The thirty-four participants hailed from milk sheds across all four provinces. The Sector Animal Resources Officers (SARO), Rwanda Dairy Development Project (RDDP Phase I), Inyange Industries (the leading dairy processor in the country), milk collection centers, as well as RAB.

When reconnecting with the trainees in September 2024, we found mixed results regarding the use of the Zirakamwa. One of the participants from the Western Province, Jean-d Amour Niyonteze, affiliated with Inyange Industries, had, in fact, trained eight medium-scale dairy farmers who installed the app on their phones. They primarily used the ration formulation component of the app but noted that some common feed grasses/forage species were not considered in the app. Despite that shortcoming, following the ration formulation guidance from the app helped increase production: one woman went from 100 liters a day to 300 liters a day (L/d) with 15 cows. One cow is even producing 40 liters/day making her the absolute star of the farm! While the emphasis has been on feed formulation improvements, this farmer also improved general management practices addressed in the other component of the app. She used some of the increase in earnings to invest in a milk cooler.

While the number of users and measured improvements are still small, Jean-D' Amour Niyonteze has noticed a change in behavior in those using the app, especially when it comes to feeding their animals. For one farmer, the ration formulation tool helped to tailor diets to the physiological stage of the animals, resulting in healthier animals and increased production from 150 to 200 liters from his 17 cows. He also changed how he is feeding the calves. Ultimately, he would like to be able to produce 1,000 liters a day, and although that may still take some time, he feels he is on the right path!

Interview on the use of the Zirikamwa app. Photo credit: A. Bohn, LSIL

Another trainee, Claire Mukawera from Gakenke district affiliated with Inyange Industries, reported primarily using the farm assessment component of the Zirakamwa app. She found the farm assessment helpful to guide farmers on how to systematically improve their practices. Some farms have started implementing the recommendations, which have resulted in higher productivity, and other farmers are starting to notice the difference. Record keeping is a challenge for many farmers, but they do recognize its usefulness. And while some

do, many farmers do not see any benefit from utilizing the ration formulation component of the app because they mostly feed Napier grass, sometimes supplemented with maize bran and providing mineral licks to the animals. They either do not have access to other feed ingredients or feel they cannot afford them.

What have we learned?

Technology adoption takes time and is not a linear process. What problem is the solution is supposed to resolve? Does the technology fit the context? Training on how to use a tool is necessary but should not be a one-off. There needs to be follow up on how well the technology is working and what barriers clients may face in utilizing it well.

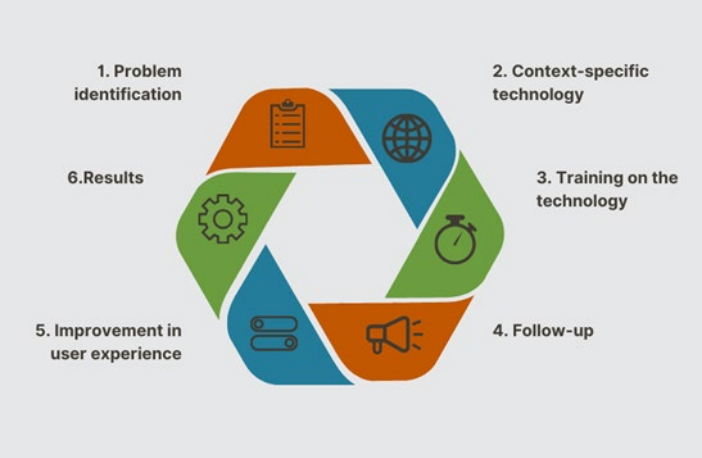

Figure 3 Technology adoption cycle of the Zirakamwa App

There is much deliberation on how the uptake of innovations developed by the research for development projects funded by USAID can be improved. The experience with the farm assessment tool, its genesis from a spreadsheet to a user-friendly mobile app, and the ongoing journey of supporting more widespread adoption in Rwanda shows that this is an iterative process that requires multiple engagements with stakeholders and users to eventually get it right. There are tools to support this process: The Innovation to Impact (i2i) learning platform at https://usaid.s4prod.com/#/ is a great example of this, and in 2024, the Livestock Systems Innovation Lab used it to identify applicants with the most promising innovations for improving livestock systems and animal source food consumption. If i2i had been available in 2018, perhaps the Zirakamwa journey may have looked different!

Geoffrey Dahl, Innovation Lab director and a professor in Dairy Sciences who helped design the initial tool, concludes: "As an Innovation Lab and UF, we aim to continue working with farmers and extension providers in Rwanda and other countries where the app has been deployed to further improve it to meet local needs"

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