SAMUEL KILONZO MUTIGA

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Current position: Lecturer (Plant Pathology), Department of Botany, Maseno University, Private Bag, Maseno

EDUCATION

Doctor of Philosophy, Plant Pathology, 2014, Cornell University, USA
Thesis: Insights into the Genetic and Environmental Bases of Mycotoxin Contamination in Kenyan Maize

Master of Philosophy in Plant Protection, 2008, Moi University, Kenya
Thesis: Effects of integrating companion cropping and nitrogen application on the performance and infestation of collards by *Brevicoryne brassicae*

Bachelor of Science in Horticulture, 2004, Moi University, Kenya
Degree classification: Second Class - Upper Division (Honors)

PROFILE SUMMARY

I am a plant pathologist with extensive experience in field and laboratory-based research, supporting farming communities through extension and training, stakeholder engagements, resource mobilization and capacity building for junior scientists. My research focuses on sustainable plant disease control strategies using modern innovative approaches for enhancing durable resistance. In the past, I have worked with international research collaborative teams to tackle the aflatoxin contamination problem in maize and rice, and other vulnerable food stuffs. As a doctoral student at Biosciences of eastern and central Africa (BecA), I pioneered in developing the proposal for the Capacity and Action for Aflatoxin Control in East Africa (CAAREA) project which was funded by the Australian Department of Foreign Affairs and Trade (DFAT) up to $5 million between 2011 and 2016. The CAAREA project established a world class mycotoxin and nutritional analysis laboratory at the International Livestock Research Institute in 2011. Thereafter, I was a recipient of the Global Hunger Alleviation award (The First Presbyterian Church of Ithaca, NY, 2011) and a Leadership Enhancement in Agriculture award (Norman Borlaug Foundation in 2012). As a postdoctoral research fellow at the University of Arkansas, I worked with an international team of plant pathologists and breeders to develop a proposal which was funded by the British Biotechnology and Biological Sciences Research Council (BBSRC) with up to GBP £1.5 million in 2019. The BBSRC funded project supported efforts to tackle rice blast disease through pathogen characterization and breeding for resistance in Africa. As part of my career advancement goals, I am seeking a faculty position in an institution where I can establish a research platform for conducting regional research and training of junior scientists. I plan to use the university research platform to mobilize resources through my international collaborative networks to facilitate research and product development for tackling major plant diseases and other crop production constraints in Kenya and beyond.

SKILLS ACQUIRED THROUGH FORMAL TRAINING AND EXPERIENCE

1. Team leadership and capacity building in agricultural research.
2. Public speaking, stakeholder engagement, forming partnerships and international experience.
3. Proposal development and scientific writing with a good publication record in high impact journals.
4. Teaching: basic plant and advanced pathology, mycology, microbiology and research methods.
5. Costing of plant breeding operations using the University of Queensland Breeding Costing Tool.
6. Design of experiments in the laboratory and in the field, and excellent data exploration and analysis in JMP PRO, SAS and R.
7. Pest and disease identification based on symptoms in the field and molecular diagnostic methods.
8. Data capture using computer handhelds – high throughput phenotyping with barcoded designs for data capture and uploading into computers.
9. Dryland farming and agronomy: Crops produced over 5 hectares under dryland conditions include maize, dry bean, mung bean, pearl millet, sorghum, mangoes, citrus and papaya.
10. Mycology and microscopy, including fungal culturing, counting and imaging of cells.
11. Nucleic acids extraction and analysis, primer design, PCR optimization, PCR diagnostics and quantification, and basic bioinformatics.
12. Diagnostic and analytical chemistry: nutritional and Mycotoxin content analysis using fluorometry, ELISA, UPLC, UV-VIS and NIRS.

WORK EXPERIENCE

Consultant Plant Scientist – International Maize and Wheat Improvement Center – 2023 to 2024

The position involved supporting breeding programs to cost their pipelines and to analyze genetic gains based on historical germplasm evaluation data for key traits of different crops in Africa. One of the outputs from this is a publication in **Frontiers in Plant Sciences**: doi: 10.3389/fpls.2024.1416538.

Postdoctoral research fellow (University of Arkansas) and visiting scientist (Biosciences eastern and central Africa – International Livestock Research Institute) 2019 to 2022

My key role was to coordinate Durable Rice Blast Resistance for sub-Saharan Africa – a research project funded by Biotechnology and Biological Sciences Research Council (BBSRC) through the Sustainable Agriculture for sub-Saharan Africa Initiative. The international partnership included scientists from the African Rice Center, International Rice Research Institute (IRRI), Kenya Agricultural and Livestock Research Organization (KALRO), Tanzanian Agricultural Research Institute (TARI) and the Institute of Environment and Agricultural Research (INERA), Burkina Faso who were focused on application of modern breeding approaches to enhance rice blast resistance in sub-Saharan Africa. I played the following specific roles:

1. Led in identification of rice germplasm to constitute a panel for evaluation in the field and in the laboratory: I worked with the national agricultural research system (NARS) scientists to identify the rice parental lines for use in an introgression breeding program to enhance blast resistance in popular rice cultivars.
2. Coordinated a multilocational and lab-based germplasm rice testing through inoculation with diverse rice blast pathogen isolate collections from nine African countries: I held regular meetings with the NARS scientists to implement our experimental designs and field layout designs and

participated in the evaluation of germplasm at blast hotspots in Burkina Faso, Kenya, and Tanzania. In addition, I conducted complementary testing of the rice germplasm for resistance to blast through artificial inoculation in the laboratory at ILRI,

3. Led in conducting of surveys to identify the popular rice cultivars and their response to multiple stresses across the participating African countries. During these surveys, we met farmers in their fields and worked closely with the agricultural extension officers to identify the challenges faced by the farmers and ways to mitigate them.
4. Developed factsheets for rice production in east Africa. Included were the pre- and post-harvested practices, pests and diseases, and the management approaches. These are now available publicly at KALRO rice knowledge bank.
5. Participated in outreach and extension program to build capacities for disease diagnostics and varietal choice: while working in collaboration with KALRO and CABI scientists, I played a leading a role in enhancing training of thirty-seven agricultural extension agents to be able to diagnose rice production constraints and to advice on mitigation approaches.
6. I worked closely with the relevant institutional and government offices to obtain the material transfer agreements and the permits within the regional phytosanitary framework to enhance sharing of seed within the research consortium. Thereafter, I would distribute the test rice germplasm among the collaborating teams,
7. Strengthening of biobank and online repository/database: I played the establisher and custodian roles and supported the enrichment of a biobank for collections of isolates of *Magnaporthe oryzae* from nine African countries. Additionally, I identified the components/structures of the project and included them in an online database. The database carries the rice germplasm and pathogen passport information, protocols, and experimental results for the project in a secured institutional portal,
8. Preparation of regular project reports and manuscripts. Notable in my research efforts is the contributions in developing a breeding scheme and characterization of resistance based on prevalence and effects of known blast resistance genes (see in publications section - Mutiga et al., 2017 &2023: Phytopathology and Plant Disease 2021, APS), and a cross-sectional survey to identify the popular rice varieties and their response to foliar diseases in Kenya (Nganga et al. 2022; Plants, MDPI),
9. Mentored four graduate students who are conducting research in the fields of plant pathology (including Everlyne Mumbua, MSc. Maseno University, 2023) and breeding.

Postdoctoral Research Associate (University of Arkansas) and visiting scientist (Biosciences eastern and central Africa – International Livestock Research Institute) 2014 to 2018

1. The key role was to take a lead in developing blast resistant rice varieties for Africa in a Sustainable Crop Production Research for International Development initiative which was funded by BBSRC.
2. Led in the characterization of a core collection of *Magnaporthe oryzae* isolates (n=122) through artificial inoculations on rice differentials carrying known blast resistance genes, vegetative

compatibility groups (at the University of Arkansas), and genotyping of the isolates using genotyping by sequencing (GBS) platform at Cornell University.

3. Established the standard operating procedures for field and laboratory studies. These included obtaining the necessary approvals and risk assessments to initiate rice testing through inoculation with rice blast pathogen at the new Plant Pathology facility of ILRI. I initiated the biobank of the rice blast pathogen at ILRI for use by the ongoing research project and for the regional scientists to be able to screen regional germplasm for resistance to blast based on artificial inoculations upon application to use the isolates using existing biosafety procedures and regulations.
4. I established an online database for the pathogen and the associated data was also initiated to store the project information and data by working with all collaborating scientists to identify the passport data and the nature of the data generated in the field and the labs,
5. Mentored African researchers who conducted research within the BecA-ILRI hub facility with funding from the African Biosciences Challenge Fund. Among the mentees were graduate students and postdoctoral researchers from east African institutions,
6. Developed a proposal and collaborated in a Feed the Future Livestock Innovation Labs project (funded by USAID) focusing on surveillance and management of mycotoxins in animal feeds of Rwanda.

Graduate Research Assistant (R.Nelson Lab., Cornell University) and Fellow (BecA-ILRI) 2008-2014

My 2-year course work covered the following: Biology of Plant Pathogens, Concepts of Plant Pathology and Plant-Microbe Biology, Advanced Plant Genetics, Methods of Plant Breeding Laboratory, Molecular Breeding, Perspectives in Plant Breeding, Quantitative Genetics in Plant Breeding, Concepts and Techniques in Molecular Biology, Statistical methods and the regular research seminars in the Department of Plant Pathology. I accomplished the following activities during my doctoral research:

1. I collaborated with researchers from Cornell, University of Maryland, ILRI and KALRO in designing studies to identify the factors made Kenyan maize to be vulnerable to aflatoxin contamination,
2. I used ArcGIS to identify the maize growing agroecological zones of Kenya. Then, I worked with personnel from the Kenyan Ministry of Agriculture and Tegemeo Institute (Egerton University, Njoro, Kenya) to identify the varieties that were grown across different regions of Kenya, as this was important in designing a survey to enhance accuracy in data collection and reporting,
3. I led in designing and implementation of a survey with a stratification across five agroecological zones within maize growing regions of Kenya to collect maize samples and to conduct interviews on maize varieties, varietal characteristics, pre-harvest crop practices and post-harvest management and handling methods. In total over six thousand samples were collected from Eastern and Western Kenya and were delivered to ILRI for analysis of aflatoxin between 2009 and 2010.
4. The large sample size forced me to learn how to develop a relational database to enhance tracking and accuracy in entry of the results,
5. To collect the samples, I had to obtain research permits from different government agencies, and I made good linkages with over twenty other stakeholders during this project,
6. I participated in analysis of the samples using different techniques, including visual

assessment of grain and flour, scanning using a spectrophotometer, Enzyme-Linked Immunosorbent Assay (ELISA), Immuno-capture Fluorometry, High Performance Liquid Chromatography, conventional and quantitative PCR,

7. I had to learn how to work in a group with local and international communities, and team management to ensure that I achieved the project goals, and reported the outputs accurately,
8. The statistical skills I acquired during these studies included extensive exploration prior to analysis of data using computer applications such as Excel, R, SAS, STATA, SPSS and JMP,
9. From the surveys, I managed to report key drivers for aflatoxin accumulation maize – with two manuscripts that I published in Phytopathology (see Mutiga et al. 2014&2015).
10. In a similar study, I pioneered a Cornell-CIMMYT-ILRI partnership to study the relationship between aflatoxin contamination and nitrogen deficiency in soils within an ongoing project named Improved Maize for African Soils (IMAS). The project was focused on evaluation of maize testcrosses for performance under low and high soil nitrogen conditions. In this study, I focused on identifying the maize traits (including agronomic traits, grain physical and chemical composition) which were associated with reduced aflatoxin accumulation. From the study, we identified promising genotypes which fell in the early maturity category that were consistently resistant to aflatoxin. This work, again, gave me valuable experience with the need to network and work closely with other regional scientists in tackling similar goals. I published this work in Field Crops Research Journal (see below Mutiga et al 2017).
11. My third thesis chapter research involved a dissection of the components that explained the inherent huge genotype by environment interaction that influences aflatoxin in maize. I piloted and implemented a mature maize kernel screening assay by inoculating the grain of inbred lines and recombinant inbred lines from multiple environments in the US with aflatoxin producing isolate of *Aspergillus flavus*. I measured and scored for physical kernel traits and used chemical composition and elemental profile data from other collaborators at Cornell to determine the associations between aflatoxin and the grain traits. This study enabled me to widen my collaborative network with scientists working for USDA-ARS and other departments within the US. We reported that sulfur and magnesium influenced colonization of maize grain and aflatoxin accumulation during storage, and that where the soil factors and other environmental factors influence susceptibility to colonization by aflatoxin producing fungi. This work was published in Plant Breeding journal of Elsevier (see Mutiga et al., 2019).

Graduate Student, Moi University 2004-2008

I took a Master of Philosophy degree in Plant Protection with a major in entomology and a minor in agronomy. My course work covered the areas of Plant Pathology, Agricultural Ethics and Plant Biosafety, Crop Physiology, Entomology, Seed Health, Plant Breeding, and modeling and Research methods. My research was on effects of cropping systems and nitrogen application on damage of collards by cabbage aphids and provided key insights into the utility of local crops as intercrops in integrated pest management. This was the foundation for my basic research and gave me a good start in reporting scientific findings, as I was able to publish two scientific papers from this work (see Mutiga et al 2010&2011).

Resource Mobilization for Research

Grant title	Year	Donor	Amount	Role	Output
Understanding aflatoxin accumulation in maize and evaluating strategies to reduce human exposure in East Africa	2009	Cornell University, Atkinson Center for a Sustainable Future	$100,000	Research fellow	Four journal articles and a doctoral thesis
Global Hunger Alleviation Award	2010	The First Presbyterian Church of Ithaca	$20,000	Research Fellowship	Conducted public food safety outreach in Eastern Kenya and one journal article
Studies on genetics of the maize, the aflatoxin producing fungi, and the associated environmental factors.	2011	Cornell Institute of International Food, Agriculture and Development	$30,000	Co-investigator and research assistant	One journal article
Leadership Enhancement in Agriculture Program Award	2012	Norman Borlaug Foundation	$20,000	Research Fellowship	Established Cornell-CIMMYT-BecA link-ship for research on the association between soil fertility stress and aflatoxin
Capacity and Action for Aflatoxin Reduction in East Africa (CAAREA) funded through BecA-ILRI	2011 - 2016	Australian Department of Foreign Affairs and Trade	$5,000,000	Research fellow	Mycotoxin and nutritional laboratory analysis and associated research
Assessment and Mitigation of Aflatoxin and Fumonisin Contamination in Animals Feeds in Rwanda	2016	USAID	$100,000	Co-PI	Co-supervised one PhD student and published two journal articles
Durable Rice Blast Resistance for sub-Saharan Africa	2018	BBSRC	£1,501,699 Sub-award of £365,000 for BecA-ILRI	Investigator at BecA-ILRI	Trained two MSc. Students, developed blast resistant rice, and published three journal articles

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Teaching experience:

1. Lecturer, Moi University, Eldoret, Kenya 2007-2008: School of Agriculture and Biotechnology, Moi University, Kenya. I prepared and delivered lectures, and examined students in the following areas:
    - Plant Pathology
    - Agricultural Entomology
    - Agricultural Biochemistry.
2. Graduate teaching assistant, Cornell University, Ithaca 2010: School of Integrated Plant Sciences, Cornell University, Ithaca, NY: 2010: I was a teaching assistant for Prof. George Hurdler
   Course title: Magical and Mischievous Mushrooms (enrollment of over 500 undergraduate and graduate students). My role was to prepare for laboratory sessions for micro- and macroscopic identification of fungi, growing of mushrooms, lectures, development of laboratory protocols for the mycology laboratory, exam supervision and grading.
3. Offered a Statistical and Biometrics Module to Graduate Research Fellows who were funded to conduct research at BecA-ILRI through the African Biosciences Challenge Fund (ABCF) fellowship between 2016 and 2017.
4. Teaching the African CGIAR and NARES breeding networks personnel on costing of breeding operations using the University of Queensland Breeding Costing Tool, 2023 – to-date. This is a training on methods program which begun in 2018 and supports breeding programs which are working closely with the Genetic Innovations section of the CGIAR. The goal is to enable the breeding programs to use the tool in budgeting and re-align their resources based on the outcome of the costing of individual stages.

Supervision of post-graduate students

1. Anita Nunu, Master of Science in Plant Pathology Kenyatta University (ongoing since 2021). Thesis title: Blast Resistance in Rice with Varying Zinc and Anthocyanin Content in Kirinyaga County, Kenya. Funded by IRRI.
2. Roselyne Juma, PhD in Plant Breeding University of Nairobi (ongoing since 2020). Characterization of Rice (*Oryza Sativa* L.) Germplasm, and Evaluation for Agronomic Traits and Blast Resistance in Irrigated Ecologies of Kenya. Funded by IRRI.
3. Everlyne Mumbua Nganga, MSc. Plant Pathology, Maseno University (graduated in 2023). Thesis title: Blast Disease Levels and Agronomic Performance of Selected Rice Genotypes in Selected Counties of Kenya Under Field and Greenhouse Conditions. Her paper was published in *Plants* **2022**, *11*(9), 1264; **https://doi.org/10.3390/plants11091264**
4. Fatma Kiruwa, Master of Science, Nelson Mandela African Institute of Science and Technology (graduated in 2016). Thesis title: Identification and characterization of Maize Lethal necrotic disease in Northern Tanzania. Her work was published in Pathogens (MDPI) journal of DOI: 10.3390/pathogens9010004
5. **Richard Dooso**, Master of Science, University of Nairobi (Graduated in 2019). **Thesis title**: Assessment of Toxigenic Potential and Genetic Relatedness of *Aspergillus Flavus* Populations from Different Maize Growing Regions in Kenya. His work was published in Toxins (MDPI) journal **https://doi.org/10.3390/toxins11080467**

Other fellows mentored through ABCF fellowships at BecA-ILRI

6. Kizito Nishimiwe, PhD student at Iowa State University (graduated 2020). I co-supervised (with Dr. Dirk Maier) his thesis on prevalence of aflatoxin and fumonisin in animal feeds in Rwanda with a joint funding from USAID. He published two articles from his thesis.
7. Edossa Fikiru, PhD candidate Madawalabu University, Ethiopia. He completed his research working on mechanisms of aluminium toxicity in durum wheat and graduated in 2018. His work was Published in Agronomy, https://doi.org/10.3390/agronomy9080440.
8. Edwin Onyiego, Bachelor of Science degree in Biotechnology, Technical University of Kenya (Graduated in October 2018). Senior research project on factors influencing sporulation of *Magnaporthe oryzae* under laboratory conditions. This work was conducted at BecA-ILRI Hub, Nairobi.
9. Geofrey Kawube, Postdoctoral researcher from Gulu University, Uganda. He completed his 12-month placement in which he was involved in genome-wide association studies to identify genes associated with resistance to finger millet blast disease.
10. Marguerite Nyibutorosa, PhD student working on aflatoxin contamination and its association with the nutritional availability in soybean milk from Rwanda. She successfully completed her 9-month studies in November 2016.
11. Victoria Tibenda, Postdoctoral researcher from Ugandan ministry of agriculture and fisheries (2016): She successfully completed her 1-year research on mycotoxin contamination in fish feed. Published in Toxins (MDPI) journal https://doi.org/10.3390/toxins12040233.

List of publications (cited 798 times)

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2. Harvey, J., Macdefette, M., **Mutiga, S.,** Mutuku, J., Eldridge, T., Emmrich, P., Grace, D., Senay, S., Abate, A., Darnell, R. and Djikeng, A. 2016. Poisoned Chalice: Toxin Accumulation in Crops in the Era of Climate Change *in* Sarasas, P., Sitati, A., and McMullen, C. (eds) UNEP Frontiers 2016 Report: Emerging Issues of Environmental Concern. United Nations Environment Programme, Nairobi. pp.54-62.
3. Hoffmann, V., **Mutiga, S. K.**, Harvey, J. W., Nelson, R. J. and Milgroom, M. G. 2021. Observability of food safety losses in maize: evidence from Kenya. Food Policy, 98, 101895. https://doi.org/10.1016/j.foodpol.2020.101895.
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5. Hoffmann, V., **Mutiga, S. K.**, Harvey, J., Nelson, R. J., and Milgroom, M. G. 2013. Asymmetric Information and Food Safety: Maize in Kenya *in* Agricultural and Applied Economics Association (AAEA) Annual Conferences Meeting, August 4-6, 2013, Washington, D.C. AgEcon Search, 10.22004/ag.econ.151288
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prepared for presentation at the Agricultural & Applied Economics Association's 2013 AAEA & CAES Joint Annual Meeting, Washington, DC.

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8. Kizito N., Erin B., Jean de Dieu Ayabagabo, Habimana R., **Mutiga S.** and Maier D. 2019. Assessment of Aflatoxin and Fumonisin Contamination and Associated Risk Factors in Feed and Feed Ingredients in Rwanda.Toxins https://doi.org/10.3390/toxins11050270
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10. Mgonja, E. M., Park, C. H., Balimponya, E. G., Kang, H. Opiyo, S., Bellizzi, M., **Mutiga, S. K.,** Rotich, F., Devi Ganeshan, V., Mabagala, R., Sneller, C., Correll, J., Zhou, B. Talbot, N. J., Mitchell, T. K. and Wang, G.L. 2017. Genotyping-by-sequencing-based genetic analysis of African rice cultivars and association mapping of blast resistance genes against *Magnaporthe oryzae* populations in Africa. Phytopathology, 107(9), 1039-1046: DOI: 10.1094/PHYTO-12-16-0421-R
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Contributions in journals as a reviewer

Applied Sciences, Biocontrol, Crop Protection (Elsevier), Food and Nutrition, Genomics, International Journal of Microbiology, Nature Scientific Reports, Peer Journal, Phytopathology (APS), Plant Disease (APS), World Mycotoxins, and MDPI journals (Plants, Agriculture, Agronomy, Toxins, Pathogens, Molecules and Sustainability).

Conferences and workshops organized/participated

1. CGIAR initiative on Accelerated Breeding Leadership in research management training between 11th and 13th June 2024 at Two Rivers Hotel, Nairobi, Kenya
2. Planned and facilitated training of CGIAR and NARES breeding network fellows on costing of breeding operations during a workshop held at The Concord Hotel, Nairobi between 13th and 16th May 2024
3. Modern Breeding – Costing of Breeding programs workshop organized by ABI- Transform and IITA between 26th and 29th May 2023 in Ibadan, Nigeria
4. Genetic Gains Analysis and Data Management workshop organized by ABI-Transform between 6th and 8th September 2023 CIMMYT, Nairobi.
5. Organized, moderated and presented orally in a **Durable blast resistance for sub-Saharan Africa inception workshop**. 11-15th August 2019 Morogoro, Tanzania
6. Organized and presented a poster at **International Rice Blast Conference** 9-16th October 2016. Manila, Philippines
7. Organized and participated as a panelist in a stakeholder's workshop for the **Capacity and Action for Aflatoxin Reduction in Eastern Africa (CAAREA)** held at ILRI Nairobi campus on 19th October 2016
8. Organized and participated as a panelist in a stakeholder's workshop for the **Capacity and Action for Aflatoxin Reduction in Eastern Africa (CAAREA)** held at Mvuli, Arusha, Tanzania on 21st October 2016
9. Oral presentation during a workshop on Breeding for **Durable resistance to rice blast disease in Africa 5-7th**May 2015. Naivasha, Kenya.
10. **Cultivar development workshop** organized by BecA-NARS-DAW Agrosciences. 8th - 12th February 2016, ILRI, Nairobi.
11. Participated in a **Genomic selection** workshop organized by BecA-ILRI/Cornell University. November 2015. ILRI, Nairobi.

References

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