CONTRIBUTION OF UNIVERSITY OF ELDORET RESEARCHERS TO NATIONAL DEVELOPMENT

Universities play a key role in the development of human resource for all production sectors of the economy through training and conducting research and development for the generation, curation and dissemination of new knowledge. University research programmes are critical in the development of theoretical foundations in basic sciences that underpin applied research. A great proportion of research funding initiatives focus more on applied research, seen to generate quick gains as opposed to basic research, whose benefits are not always apparent. The research portfolio at universities has been declining over the years due to low funding and greater focus on training.

The world over universities is responsible for research, knowledge generation, scholarship and innovation that is necessary for driving local social, technological and economic development. They are also relied upon to serve as conduits for the transfer, adaptation and dissemination of knowledge that is generated worldwide. Kenyan universities are facing renewed external and internal pressure as the push for them to meet the changing needs of the country become more pronounced. The country is quickly moving towards a knowledge-based economy and there is urgent need for new products and services. This raises the need for good coordination of university research to facilitate a process of national dialogue on what information exists in the country, its storage and utilization as well as setting the agenda for future research to address our national development goals and dilemmas. Given the high cost of research, questions are now being asked about the relevance and impact of university on national development especially in developing countries.

University of Eldoret Research Environment

The Planning, Research and Extension Division of the University of Eldoret was created among other things to coordinate and promote research activities at the university. The division in performing its functions spearheaded the drafting and approval of the 2019-2024 Strategic Plan to provide informed guidance to all University activities. In the plan, research is given prominence as strategic objective number 2 which strives *to position the University as a research center*. Research plays a very significant role and is part and parcel of the University's core function which is academics. The research activities are cross cutting but is coordinated within the division by the Directorate of Research and Innovation.

The University of Eldoret's research environment encourages innovative, cross-disciplinary and collaborative research. Research is at the heart of our heritage, our present and our vision for the future. Our discoveries have shaped the world today and our research environment spreads far beyond our campus. We maximize our impact through external funding, licensing, supporting enterprise and partnering with other organizations, institutions bringing benefits to individuals, businesses and communities.

With a breadth of research activities (Postgraduate and academic staff) that's unrivalled in Kenya, we work across disciplines and beyond the University, connecting the brightest minds to find innovative solutions to the world's greatest challenges. At the University we actively support our researchers and postgraduate students in the development of their careers. We offer our research staff a range of excellent training and development opportunities, delivered by dedicated researcher development teams based in each of our academic departments, as well as by the University's professional and support services. World-class research lies at the heart of everything we do at the University. It informs our courses, unites our disciplines, brings innovation to industry and transforms lives across the globe. We take full advantage of our size and breadth, bringing the best minds together from diverse disciplines and cross-sector partnerships to forge new ways forward in multiple fields. UoE's research beacons are exemplars of this collaborative ethos, finding innovative solutions to some of the biggest challenges facing the planet today.

The University of Eldoret faculty continues to attract research funds from different funding organizations to conduct need driven research which aims and solving national and societal problems. Below is a highlight of some of the research activities at the University.

1. **Development of a National Biomonitoring protocol for Kenya Rivers (The KISS Project)**

The Development of a National Biomonitoring Protocol for Rivers in Kenya (The Kenya Invertebrates Scoring System - KISS) is a collaborative Multidisciplinary Research Project funded by the National Research Fund (NRF) to the tune of KES 11.9 Million. The project brings together scientists from the University of Eldoret, Egerton University and the National Museums of Kenya (NMK). Members of the research team include Dr. Frank Masese, Prof. Phillip Raburu, Prof. Boaz Kaunda-Arara, Dr. Simon Agembe, Dr. James Barasa, Dr. Geraldine Matolla and Mr. Alfred Otieno (UoE), Prof. Charles M'Erimba and

Prof. Nzula Kitaka (Egerton University) and Mr. Laban Njoroge (National Museum of Kenya).

The Principal Investigator of the Project is Dr. Frank Masese, Senior Lecturer at the Department of Fisheries and Aquatic Science. Dr. Masese, an alumnus of the Department of Fisheries and Aquatic Science, holds a PhD degree on Freshwater Ecosystems (Wageningen University & Research, and IHE Delft Institute for Water Education, the Netherlands) and a Postdoctorate in Ecohydrology from the Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB), Berlin, Germany. He has over 15 years of research experience investigating the influence of land-use change and human activities, including livestock and large wildlife populations, on water quality and the structure and functioning of riverine ecosystems in Kenya.

Dr. Masese has particular interest in biomonitoring utilizing macroinvertebrates and fishes, to which he has contributed towards the development of biomonitoring indices in streams and rivers in Kenya. Dr. Masese has worked on several projects (both with national and international collaborators) in East Africa and Europe (Austria, Albania and Germany). He has several journal publications and book chapters, and is currently on the editorial board of the journals *Freshwater Biology and Frontiers in Water*.

Rivers forms a very significant component of the landscape offering specific goods and services to aquatic biota and the livelihoods of riparian communities. Surface water quality is rapidly declining in Kenya, as a result of human populations growth and the resultant intensification of agriculture, urbanization, increased domestic and industrial wastewater discharges. Maintenance of water quantity and quality to meet rising demands for domestic, industrial and other use, such as irrigation, is an increasing challenge. Protection of surface waters in streams, rivers, wetlands and lakes is a

prerequisite for freshwater biodiversity conservation and is universally recognized as avital element of societal wellbeing.

In order to assess the condition of surface waters, the National Environment Management Authority (NEMA) relies mostly on measurement of water quality physicochemical parameters, with the aim of maintaining them within recommended thresholds. Following this approach, wastewater discharge standards have been set for most water quality parameters and pollutants, to reduce the potential for compromising the quality of water in recipient ecosystems. Such an approach to protection of surface water is fraught with problems, mainly because levels of contaminants and parameters can vary strongly over short periods of time. This method is also expensive and lacks the integrative capacity to inform water resources managers and environmentalists about the effects of pollutants on biodiversity and overall ecological integrity of aquatic ecosystems.

Pioneering studies by Prof Phillip Raburu and his postgraduate students in the last two decades on biomonitoring of ecological integrity of riverine ecosystems in the Lake Victoria Basin prepared a firm background for the KISS Project. Aquatic organisms especially macroinvertebrates used as bioindicators have been found to be superior to chemical analyses because they integrate pollutant loads accumulated over long periods of time. Internationally the trend is to develop national or regional biological protocols for monitoring water quality and overall ecological integrity of aquatic ecosystems. Currently there is no biological criterion for assessing and monitoring the condition of aquatic ecosystems in Kenya. The KISS Project was developed to bridge this gap by developing a rapid and cost-effective biomonitoring protocol for assessing and monitoring water quality and ecological integrity of streams and rivers in Kenya.

The project is currently on its third year, and 75% of data have been collected from five major ecoregions in the country (Lake Victoria Basin, Coastal region, Mt Kenya, Rift Valley and Arid and Semi-Arid Lands (ASALs)), using standard sampling procedures. The data collected are being used to develop a national rapid bioassessment protocol, to be called the Kenya Invertebrates Scoring System (KISS), while fish data will be used to validate the protocol. Once developed, national and county water resources managers, environmentalists and other stakeholders, including students, will be trained on the use and importance of the protocol. The findings will be disseminated widely in form of reports and policy briefs to government agencies in order to guide sustainable management of water resources in the country.

Team collecting water quality data by on-site filtaration (above) at Nyakwere Bridge, Sondu-Miriu River, and in situ logging using Hydrolab sondes (MS5, Hach Hydromet) (below)

Team members collecting fish samples from Mara River using an electrofisher, The most efficient methodology recommended which developing Fish Biomonitoring Indices. Photo Credit- Evans Ole Keshe

The project outputs to date include:

i) Supporting 3 MSc students (Augustine Sitati, Mourine Yegon and Elizabeth Wanderi) and one PhD student (Alfred Achieng) to collect data for their theses.
ii) Database on aquatic biodiversity and status of streams and rivers in Kenya
iii) Characterization of streams and rivers according to biodiversity, ecoregion (ecological zone), and pollution type.
iv) List of fishes and macroinvertebrate taxa and their tolerance to water quality and habitat degradation in Kenya.
v) Manual on the use and application of the bioassessment protocol.
vi) Research articles that have already been published or are in submission / preparation include:

Published articles

Achieng AO, Masese FO & Kaunda-Arara, B. (2020). Fish assemblages and size-spectra variation among rivers of Lake Victoria Basin, Kenya. *Ecological Indicators*, *118*, 106745.

Masese FO, Achieng AO, Raburu PO, Lawrence T, Ives JT, Nyamweya C & Kaunda-Arara B. (2020). Distribution patterns and diversity of riverine fishes of the Lake Victoria Basin, Kenya. *International Review of Hydrobiology*, doi:10.1002/iroh.202002039

Masese FO, Achieng' AO, O'brien GC, & McClain ME. (2020). Macroinvertebrate taxa display increased fidelity to preferred biotopes among disturbed sites in a hydrologically variable tropical river. *Hydrobiologia*, doi:10.1007/s10750-020-04437-1

Achieng' AO, Masese FO, Coffey TJ, Raburu PO, Agembe SW, Febria CM, Kaunda-Arara B. Physicochemical assessment of stream health of Afrotropical rivers using fish assemblages: A case of the Lake Vitoria Basin, Kenya. *Frontiers in Water*. DOI:10.3389/frwa.2020620704

Articles in submission and in preparation

Sitati A, Raburu PO & Masese FO. Functional organization of macroinvertebrates in response to land use in the Nzoia River. *Limnologica.* In Revision

Sitati A, Masese FO & Raburu PO. Functional organization of macroinvertebrate assemblages as surrogates of ecosystem attributes in Afrotropical streams. *Ecological Indicators*. In Review

Nakangu NF, Barasa JE, Matolla GK, Riziki JW, Molongaibalu M, Masese FO. Food composition and condition factor in *Labeo victorianus* in rivers of Lake Victoria Basin, Kenya. *African Zoology*. In Review

Masese FO, Sitati A, Yegon MJ, Achieng' AO, Agembe SW, Barasa JE, Matolla GK, Raburu PO, Kaunda-Arara B. Development of a flow sensitive index of biotic integrity for

assessing ecological condition of highly hydrologically variable tropical rivers. In preparation.

Sitati A, Yegon MJ, Achieng' AO, Agembe SW, Barasa JE, Matolla GK, Raburu PO, Kaunda-Arara B, Masese FO. Structural organization of macroinvertebrates in response to catchment land use in the Nzoia River, Kenya. In preparation.

Masese FO, Achieng' AO, Agembe SW, Sitati A, Barasa JE, Matolla GK, Raburu PO, Kaunda-Arara B. Influence of multiple stressors on fish assemblages in a dry-wet tropical savanna river. In preparation.

Masese FO, Achieng' AO, Agembe SW, Sitati A, Mourine Yegon, Barasa JE, Matolla GK, Raburu PO, Kaunda-Arara B. Influence of multiple stressors on macroinvertebrate communities in a dry-wet tropical savanna river. In preparation.

In a nutshell, the project contributes to the attainment of Vison 2030 and Sustainable Development Goals on water provision, conservation of water resources and protection of the environment. On successful completion, the project will provide the first ever protocol for biomonitoring water quality in Kenyan rivers and streams.

2. **Leishmaniasis in Mt. Elgon: Vector(s) species, Reservoir Host(s) species and Innovative Approaches to their Control"**

Prof. Moses M. Ngeiywa

Prof. Moses Ngeiwa's is currently conducting a Multi-disciplinary research funded by the National Research Fund on "*Leishmaniasis in Mt. Elgon Focus: Vector(s) species, Reservoir Host(s) species and Innovative Approaches to their Control*" (Project number NRF/2/MMC/334). Prof. Ngeiywa is a PhD trained Parasitologist (DAAD Alumni; Moi University/Bonn University laboratory experience) with long service in the department of Biological Sciences. His research interests are in Biomedical Sciences specializing in Epidemiology of protozoan diseases. As PI in the current project, he collaborates with other specialists in UOE (Dr. Judy Makwali), KEMRI (Johnstone Ingonga), Moi University (Moris Kong'ong'o) and University of East Africa, Baraton (Prof. Obey).

Leishmaniasis is a vector-borne parasitic disease caused by about 20 confirmed species of *Leishmania* mostly transmitted by about 30 described phlebotomine sand flies. The disease is transmitted through the bite of infected female sandflies belonging to the *Phlebotomus*, *Lutzomyia*, and *Psychodopygus* species. These nocturnal insects bite from dusk to dawn and are often found in forests, stone and mud walls cracks, caves and animal burrows. They are very tiny silent fliers which do not hum and their bite might go unnoticed.

Leishmaniasis is clinically divided into three major categories; cutaneous, mucocutaneous, and visceral. The infection is classified as a neglected tropical disease (NTD) affecting mostly poor people in poor countries. In nature, infected animals and the vectors maintain the transmission cycle of the parasite. About 4 to 12 million people are

currently infected by leishmaniasis in some 98 countries with 2 million new cases and between 20 and 50 thousand deaths occurring each year. Zoonotic cutaneous leishmaniasis is estimated to cause about 700,000 to 1.2 million new cases of human infections per year. This form of leishmaniasis was confirmed in some regions of Rift valley and in Mt. Elgon region in Kenya more than 40 years ago but no control measures have ever been implemented. The parasite's reservoir hosts in Mt. Elgon focus were then incriminated as the rock hyrax, the tree hyrax, and the giant rat but no parasites were isolated from these suspected reservoir hosts and other animals have never been investigated as possible reservoir hosts. *Phlebotomus pedifer* and *P. elgonensis* were implicated in the transmission of leishmaniasis in Mt. Elgon focus but these vector species were identified only morphologically, thus there is need to confirm the taxonomic identities of the vector(s) using the more sensitive molecular techniques.

The temporal and spatial distribution of sand flies depends on local geographical and climatic factors. There is need to carry out comprehensive studies of these factors to correlate to vector population distribution and thus inform targeted control. Control of vector-borne disease can target the vector, the definitive host or the reservoir host. Success of control strategy will depend on thorough understanding of the epidemiology of the disease.

The current status of epidemiological data on leishmaniasis in Mt. Elgon region is lacking and this is needed to enable targeted cost effective and environmentally friendly control of the disease. In addition, the role of anthropogenic activities should be considered and incorporated in disease control measures. The funded project aims at analysis of the above vital data to enable modeling of targeted control of the disease. The expected results can be applied to control the disease in Mt. Elgon and other regions experiencing the disease.

The project is in its first year of implementation and updates on the outputs will be shared in subsequent reviews.

3. **DNA Barcoding and molecular characterization of small-sized clariid catfishes of the Lake Victoria basin, Kenya, for improved utilization**

This research project aims at improving food fish production by identifying the *Clarias* species of the Lake Victoria basin, for possible use in artificial propagation at hatcheries and to contribute to improved conservation of clariid catfish resources by determining and describing genetic diversity indices of the species and populations. This three year project is a collaboration between the University of Eldoret and Biosciences Eastern and Central Africa-International Livestock Research Institute whose Principal Investigator is Dr. James Barasa. The other team members include: Francesca Stomeo, Roger Pelle, Emily Chemoiwa, Martina Kyallo, and Jean-Baka D. Entfellner.

Clariid catfishes are a diverse group of fishes endemic to Africa. The genus *Clarias* has many species spread in different habitats, including lakes, rivers, streams, swamps, and reservoirs. The African catfish, *Clarias gariepinus*, is the main farmed Clariid catfish species in Africa, where it competes with tilapias as the species preferred by farmers in different countries. Unlike tilapias, farmed *C. gariepinus* grows fast, has higher fecundity, higher meat content and thrives on a wide range of diets, attributes that contribute to profitable aquaculture ventures. However, *C. gariepinus* has poor survival at larval stages, and this limits availability of adequate and quality seeds to support expanded culture of the species. Recent research efforts to address this challenge have focused on genetic characterization of populations of *C. gariepinus* to identify any with attributes suitable for use as better sources of broodstock at hatcheries. An alternative strategy would be to use a different species of *Clarias*, whose larvae may have higher survival rates. Many small-sized *Clarias* species exist in the Lake Victoria basin, and could form such suitable candidates. However, their identity is uncertain, because of identification has relied mostly on morphological keys that are less powerful tools. This project used DNA Barcoding techniques to identify small-sized catfishes of Lake Victoria basin, Kenya, to improve their sustainable utilization.

The project is funded by University of Eldoret Annual Research Fund and Biosciences Eastern and Central Africa-International Livestock Research Institute (BecA-ILRI Hub). Some of the key Findings include Identification of 3 different species of *Clarias* (catfishes) in the Lake Victoria basin of Kenya, in addition to the common African catfish *Clarias gariepinus*. These include *Clarias liocephalus, C. alluaudi*, and *Xenoclarias*, distributed in different sites of Lake Victoria, Lake Kanyaboli, the University of Eldoret reservoir and several rivers draining into Lake Vitoria. Key beneficiaries to the project findings include Fish farmers, Fish hatchery operators, Fisheries Resources managers, researchers, and the scientific managers.

Dr. James Echessa Barasa holds a PhD in Aquaculture from the University of Eldoret, MSc from Moi University (Aquaculture) and BSc (Zoology) from Kenyatta University, Kenya. He is a member of academic staff in the Department of Fisheries and Aquatic Sciences, University of Eldoret and teaches courses in Aquaculture focusing on Fish breeding, Genetics and Biotechnology, both at undergraduate and Graduate levels

Dr Barasa's research interest focuses on genetic identification and profiling of Clariid catfishes of Kenya, using different molecular tools, to support improved breeding and sustainable utilization. Results from these studies have been disseminated to the Scientific community and associated stakeholders through publications and by presentation at different Scientific conferences, both regional and international levels. Some of the recent research activities he has carried out include:

- ❖ Genetic diversity and Population structure of riverine smooth head catfish, *Clarias liocephalus* (Boulenger 1898) of Lake Victoria basin, Kenya.
- ❖ Multilocus heterozygosity-Fitness correlations as a tool for Brood stock choice for imprved *Clarias gariepinus* aquaculture in Kenya
- ❖ How many Clariid catfish species inhabit Lake Victoria basin today? Insights from Molecular and morphological analyses.
- ❖ Higher genetic diversity in Lake Kanyaboli than Lake Victoria *Clarias liocephalus*: evidence from mitochondrial DNA sequences.

To further his research, Dr. Barasa in collaboration with Prof. Phillip Raburu as the Co-PI's won a National competitive Institutional Infrastructure Support Programme by the National Research Fund (NRF) in 2018 to develop a **Fish Genetics and Genomics Research and Training Laboratory**. The laboratory will provide requisite and modern infrastructure to support research and training in the area of Genomics in agricultural, environmental, health and Natural resource management in Kenya and the region. The research facility which is in its final stages of establishment, will serve both staff and graduate students of the University of Eldoret, as well as other Institutions in the Western Kenya. Apart from providing the equipment for molecular experimental work, the

laboratory will also feature a Bioinformatics Platform, to support statistical analyses and computations, especially for large datasets from Next Generation Sequencing platforms.

The recent publications by Dr. Barasa include:

i) Alal, G. W., **Barasa, J. E**., Chemoiwa, E. J., Kaunda-Arara, B., Akoll, P. and Masembe, C. (2021). Genetic diversity and Population structure of selected lacustrine and riverine populations of African catfish, *Clarias gariepinus* in Kenya. *Journal of Applied Ichthyology*, **37**: 427-438. https://doi.org/10.1111/j.1558- 5646.1965.tb017 31.x

ii) Svardal, H. et al., (2020). Evolutionary genomics at the Environment-Human interface in Africa. A perspective. *Molecular Biology and Evolution*, **132**: 1-5.

iii) **J. E. Barasa,** S. Mdyogolo, R. Abila, P.J. Grobler, M. N. Njahira, R. A. Skilton, Chemoiwa, E. J., O. G. Dangasuk, B. Kaunda-Arara and E. Verheyen. (2017)**.** Genetic diversity and Population structure of African catfish, *Clarias gariepinus* in Kenya: Implications for aquaculture and conservation. *Belgian Journal of Zoology*, **142** (3): 105-127. https://doi.org/10.26496/bjz.2017.9

iv) **J. E. Barasa,** R. Abila, P.J. Grobler, M. Agaba, E. J. Chemoiwa, and B. Kaunda-Arara (2016)**.** High genetic diversity and Population differentiation in *Clarias gariepinus* of Yala swamp: evidence from mitochondrial DNA sequences. *Journal of Fish Biology*, **89** (6): 2557-2570.   https://doi.org/10.1111/jfb.13150

v) **J. E. Barasa**, R. Abila, P.J. Grobler, O.G. Dangasuk, M.N. Njahira and B. Kaunda-Arara (2014). Genetic diversity and gene flow in *Clarias gariepinus* from Lakes Victoria and Kanyaboli. *African Journal of Aquatic Science*, **39** (3): 287-293. http://dx.doi.org/10.2989/16085914.2014.933734

4. **Biological Control of *Tuta absoluta* on Tomato**

This 2-year research project which focused on **"Biological Control of *Tuta absoluta* on Tomato using Endophytic *Beauveria Bassiana*. And *Trichoderma harzianum* in the University of Eldoret"** was funded both by the World Academy of Sciences (TWAS) Grant and the University of Eldoret Annual Research Grant. The project was implemented by Prof. Lizzy Mwamburi as the Project PI with Dr. Nicholas Rop and Laban Ngobiro as the co-investigators. The aim of the project was to; determine the viability of the two fungal entomopathogens in cow, chicken and filter mud, to determine the response of *Tuta absoluta* to *Beauveria bassiana* and *Trichoderma harzianum* – amended composts in two tomato varieties and to assess

the effects of endophytic *Beauveria bassiana* and *Trichoderma harzianum* – amended composts on root and aerial parts of two tomato varieties.

The researchers assessed the response of aerial and root dry biomass of two tomato varieties, Rio Grande and Monica F1 to two endophytic entomopathogenic fungi *Beauveria bassiana* and *Trichoderma harzianum* - amended compost; cow, chicken and filter mud. They also investigated whether the endophytes could colonize and persist in the two tomato varieties and protect the tomato plants against *Tuta absoluta* larvae. Results showed that the two endophytic entomopathogens were able to colonize and grow in the three manures and that Cow manure amended with a combination of the two endophytes significantly reduced (36%) the weights of *Tuta* larvae on the tomato variety Monica F1. However, chicken amended with a combination of the two endophytes exhibited a 33% larval weight reduction in Rio Grande variety. This information may be used in tomato production systems and *T. absoluta* larvae integrated management programs as a long-term preventive measure. The team presented this work during the 4th University of Eldoret International Conference

Roots of Rio Grande tomato variety in chicken manure amended with a. *B. bassiana*, b. *T. harzianum*, c. a combination of *B. bassiana* and *T. harzianum* and d. Control

Aerial parts (30 days) of Monica F1 tomato variety in chicken manure amended with a. *B. bassiana*, b. *T. harzianum*, c. a combination of *B. bassiana* and *T. harzianum* and d. Control

Lizzy Mwamburi is an Associate Professor of Plant Pathology at the University of Eldoret. She is a graduate (PhD) of the University of KwaZulu-Natal (SA). She did her MSc at the University of Melbourne (Australia) and BSc at Moi University. In addition, she carried out her postgraduate studies at Gottingen University, Germany.

She has mentored 30 postgraduate students (both MSc and PhD), carrying out research in biological control of insect vectors of plant and animals using grants that she has received individually and together with other researchers from various institutions. She has published widely in this area. One of her achievements is the development of environmentally friendly *Bacillus thuringiensis* (Bt) that is fed to chicken to help rid poultry houses of nuisance flies.

She is an established researcher in the area of biological control of insect pests having developed biological control methods for the fall armyworm and the tomato leaf miner, and recently won a National Research Grant for biopesticides formulation and development against the desert locust *Schistocerca gregaria*. An achievement that will see the University of Eldoret lead a team of researchers from other institutions in a biopesticide development consortium.

She has participated various trainings including NACOSTI Research Ethics that has led to her leading a team to develop of the University of Research Ethics policy. Other trainings include Strategic Leadership, Intellectual Property Management and Increasing the Development Impact of Agricultural Research. She has also participated several mentorship programmes including the New York Academy of Science 1000 girls 1000 futures, INASP Research writing, Akili DADA.

She is a recipient of several scholarships and grants including Equity and Merit Australian Government Scholarship, Commonwealth Scholarship, British Council Fellowship, Organization for Women in Science in the Developing World Fellowship, The World Academy of Sciences (TWAS) – DFG fellowship, National Research grant, American Society for Microbiology Course for Undergraduate Educators (ASMCUE) Leadership Grant for International Educators, Australia Awards Africa and The World Academy of Sciences (TWAS) Research Grants.

5. Working with small holder farmers to rehabilitate degraded landscapes and improve ecological services in Chepareria Ward, West Pokot-Kenya.

Land degradation is one among the many challenges affecting small holder farmers in drylands areas in Kenya including Chepareria Ward in West Pokot County. The drylands

farmer research network (FRN) project, is funded by McKnight Foundation through University of Eldoret to support rehabilitation of these degraded landscapes for a period of 8 years (2014-2022). This includes Inception Phase I – 18 months (November 2014 – April 2016), Implementation Phase II – 3 years

(November 2016 – October 2019) and Intensification and up/out-scaling III – 3 years (November 2019 – October 2022).

The project PI Prof. Wilson Ngétich is working with co-researchers Dr. Syphyline Kebeney, (Soil & Water Conservation), Dr. Ruth Njoroge, (Soil Fertility and Nutrition), Dr. Fred Wamalwa, (Social Scientist), Mr. Harrison Churu (Soil Biology and PhD student) and Mr. Alkamoi Bonface (Seed Scientist and PhD student) all from the University of Eldoret.

The overall objective of the project is to strengthen farmer lead rehabilitation of degraded lands to improve sustainable production of multi-purpose and drought resilient food, fodder and tree production in West Pokot county. Specific Objectives include: i) To establish and strengthen effective collaboration in rehabilitating degraded lands, scaling up interventions and influencing development of supportive policies. ii) To strengthen participatory trial research to identify, evaluate, select and promote the production of suitable crops, trees and fodder that works best for men, women and youth. iii) To establish and strengthen community based AE income generating activities that works for men, women and youth and iv) To establish new, evaluate the performance and upscale context specific soil and water conservation measures that works best in managing soil health in West Pokot County.

The output of the project to date includes the following which has impacted greatly on the community:

i) SWC structures
- ❖ 22 sand dams constructed
- ❖ Over 25 Km of terraces built
- ❖ Ban on sand harvesting – local by-laws within project area developed

ii)   Crop diversity trials
- ❖ 21 crop varieties tested and important selected trailed for community based seed system
- ❖ 3 Fodder grasses introduced, tested and adopted
- ❖ Signs of Improved food and nutrition security evident in project area

iii)   Tree Nursery
- ❖ **Setting up 3 community tree nursery** producing assorted exotic and indigenous agroforestry, fruits and fodder trees for the community.
- ❖ Several fruit and agroforestry trees raised and shared among farmers
- ❖ Proactivity in using live fences for enclosures

iv)   Poultry project
- ❖ Hatchery with capacity of 2112 chicks
- ❖ Improved and local Kienyeji chicken have been hatched and sold to farmers.

v)   Studentship

Seven students have been sponsored on a full scholarship by the project to pursue Msc. and Ph.D. degrees in Soil and Land use management (4), Seed science (1) and Agricultural Extension and Rural Development (2). Two students graduated in 2019 (MSc Agric. Extension) while the rest are ongoing.

vi)   Social
- ❖ Enhanced collaboration and networking between and among farmers and partners
- ❖ Improved community identity and recognition in SWC intervention- attracting attention of more potential partners
- ❖ Capacity strengthening- Enhanced group and individual skills in trained aspects
- ❖ Building trust, equity, inclusivity and dignity

The project has impacted greatly on over 10 villages in including Senetwo, Korellach and Chepturnguny, Chepareria with a total household estimated at 1,200 and a population of 7,000. The number of households directly involved in the project is 380 while the number of people indirectly influenced by the project is over 3,000

5. Impacts of Prawn trawling on species of Hammerhead sharks, Sawfishes, Wedgefishes, and Guitarfishes in coastal Kenya.

This collaborative project between University of Eldoret, Kenya Marine and Fisheries Research Institute and Kenya Fisheries Service is being implemented **in** Malindi-Ungwana Bay, North Coast, Kenya. The project is funded by the National Geographic Society Explorer Programme and coordinated by Prof. Boaz Kaunda-Arara. The overall goal of the project is to provide data on the by-catch levels of shark and ray species from the commercial prawn trawlers within the Malindi-Ungwana Bay, Kenya, with a focus on the endangered species of hammerhead sharks, Sawfishes, Wedgefishes and Guitarfishes. The data collected is to contribute to a management plan of the bay to ensure the conservation of shark and ray species.

By-catch from the commercial prawn trawlers

The Project has documented the diversity of sharks and rays species within the Malindi-Ungwana Bay following monthly sampling campaigns. So far a total of 21 species of sharks and rays have been recorded from the by-catch volumes. Of the species landed 10 are listed as endangered in the IUCN red list of endangered species. Some of the **Endangered** species of sharks and rays being landed from the bay by the trawlers include the, Scalloped hammerhead, *Sphryna lewini*, **Critically endangered** Giant Guitarfish, *Rhynchobatus djiddensis*, and the **Vulnerable** Giant Manta ray, *Mobula birostris*), amongst others. There is depth refugia for the endangered species mostly found within the deep

(> 150 m) sections of the bay in Malindi sections of the bay with implications for the current seasonal allocation of trawling effort by the Kenya Fisheries Service (KFS). The deep (150-200 m) sections of Malindi Bay also harbours populations of the recently discovered Sawshark, *Pristiophorous nancyae*, that is now **only known to be distributed in Kenya, Tanzania and Mozambique within the WIO region**.

The data is being analyzed in order to determine: 1. The spatial demarcation of biodiversity hot-spots within the bay for purposes of area-based conservation. 2. The seasonal and spatial distribution of species with a focus on the endangered species in order to advice on sampling effort allocation for the trawlers, 3. Modeling the influence of trawling on shark and ray abundance and fish species distribution.

The data will feed into the Fisheries Management Plan of the Malindi-Ungwana Bay and the envisaged National Plan of Action for the Management of sharks and rays in Kenya (NPOA-sharks). The project supports the IUCN endangered species initiative through the participation of the PI in the Sharks Specialist Group (SSG). This study has generated a publication on Morphometrics, distribution and catch rates of the recently discovered African Dwarf sawshark, *Pristiophorous nancyae* (Chondrichthyes: Pristiophoridae), in coastal Kenya currently under *review for publication in the Journal of Itchthyology*.

The project has supported one Ph.D. Student (Benedict Kiilu); An ecological model of the Malindi-Ungwana Bay; analysis of ecosystem structure and fishing impacts, and one M.Sc. Student (Lameck Menya): Distribution of sharks and rays within Malindi-Ungwana Bay, Kenya.

Prof. Boaz Kaunda-Arara is a Professor of Fisheries Ecology, Department of Fisheries and Aquatic Sciences, University of Eldoret. Ph.D. (Fisheries Ecology), Memorial Newfoundland. Professionally, Prof. Kaunda has had international exposure as National Geographic Explorer; Editor, Fisheries Research Journal (Elsevier), 2015-2020, Visiting Professor, Memorial University of Newfoundland, 2012-2015; Member, IUCN Species Specialist Groups (Africa Region), Member SSG of Seabreams, Grunts and Groupers; African Member IUCN Sharks MOU Committee. Member WIOMSA/World Bank Bench marking Team for SWIOFish Project (2019-2021). External examiner (Makerere, Dar es salaam, and JKUAT).

The major projects he has participated on include National Geographic Explorer 2020-2022; APPEAR/Austrian funded Aquaculture Project-STRECAFISH between Kenya, Uganda, Ethiopia, BOKU University (2014-2018). WIOMSA-MASMA sponsored regional Project on Larval Ecology Between Kenya, Tanzania and Stockholm University (2009-2011); Several minor projects funded by WWS, IFS, USFWS, PADI-Foundation.

Prof. Kaunda-Arara's research interest is in Fisheries Ecology - The dynamics of exploited populations and responses of life-history traits to exploitation. Responses of sharks and rays to exploitation pressure. MPAs and Fisheries Spillover effects. Data-Poor fisheries analysis methods. To date he has published a total of 62 publications in peer review Journals.

6. UoE-EAML Barley crop research project

The Barley Crop Research Project is a collaborative research project between University of Eldoret and East Africa Malting limited (EAML), a subsidary of East African Breweries (EABL), which is part of Diageo International. EAML is in charge of Agriculture department, which carries out barley research through University of Eldoret and malt barley production. The barley crop research project was successfully bidded for and won by UoE school of Agriculture and Biotechnology in 2010 and is being implemented in 3-year phases to date. To date the project has been funded to the tune of Ksh. 9,687,850 per year (crop season) with the budget for each phase being approx.imately Ksh 30 million. The project is coordinated by Project PI and Coordinator – Prof Julius O. Ochuodho, Department of Seed Crops and Horticultural Sciences, School of Agriculture and Biotechnology.

a) Making barley crosses in the 3rd crossing block at the University of Eldoret farm site
b) Variety released in 2013

Julius Onyango Ochuodho is a professor of Agriculture of the University of Eldoret, specialized in Seed Science and Technology. He obtained PhD from the University of Natal, South Africa (2005) and has many certificates in plant sciences both local and international. His research interest revolve around seed science and technology with interest in domestication and commercialization of underutilized indigenous species. Prof Ochuodho worked with the Ministry of Agriculture under Kenya Agricultural Research Institute till 1997, where he was a Research officer and rose to Deputy Center Director position, managing research projects and seed

certification. He was Dean of the School of Agriculture and Biotechnology and has coordinated and participated in many collaborative research projects both local and international. He has published over 50 scientific articles in reputable refereed journals and many articles in other forms of publications, including 5 Book chapters; supervised and graduated 40 MSc and 12 PhD. He was a member of RUFORUM Technical Committee for 10 years (2009-2018), charged with issuing competitive research grants, Monitoring and evaluating their implementation. Currently Prof Ochuodho is involved in Resource Mobilization for the university, Deputy Chair Agribusiness Trade Fair, Chair Board of Directorate of Research and Innovations and Chair of the Professor's Committee. He coordinates the Barley research project funded by EABL, SCIFSA, RUFORUM GTA scheme and ENABLE Youth Kenya; participates in many research projects including LEAP-Agri. He is a reviewer of some scientific journals including African Journal of Agricultural Research, African Journal of Agriculture and Rural Development and a member of Horticultural Association of Kenya and American society of Plant pathologists, among others.

The overall objective of the project was to improve barley crop production through development of varieties and improved crop husbandry . Specific objectives of the project include Development of new varieties, Improvement of crop husbandry through better agronomy, crop protection and agrochemical efficacy trials, Basic seed production, and Training students and farmers on new and innovative technologies

The following are the key outcomes / outputs of the project:

i) **Released varieties:** The project developed and released 5 new barley lines (varieties) – Fanaka, Quench, Grace, Aliciana, Cerise (Figures 1 & 2). The release of another two (Shuffle and Tipple) are at an advanced stage.

ii) **Chemical efficacy trials:** During the period of the project chemical efficacy trials were carried out on several products, many of which have been recommended for farmer use. Research on the following herbicides have been completed and forwarded for consideration by the Crop Pest products board (PCPB): – Agromine, Perk, Roundup, Vigon, Tributary, Bell Amine, Glean, Celest, Agromine, Aurora Turbo, Twigathrin, Twigabrom, Glycel, Deft. The same has been done for the following *Foliar fungicides* - Azimuth, Discovery, Quilt, MASTERCOP, Merryzole, Trichotech; Cherokee, Bontima, Stamina, Tandem, Sargo, Goddard,

Jupiter, Classic, Acanto plus; *Insecticides* - Bullet, and *Foliar fertilizers* – Allwin top, Kuzar, Topsil, Lithovit

iii) **Education and Training:** The project has contributed immensely to training of students and staff. In Phase I (2010 – 2013) 8 MSc students were funded and trained in Agronomy (1), Breeding (3), Pathology (1), seed science (2) and soil science (1) out of these, 6 students successfully completed their studies and graduated. In Phase II (2013 April to 2016 March) one PhD Pathology and two MSc Agronomy students successfully completed their courses while one is still going on. currently in Phase III, three MSc students are undergoing training with one in Seed technology, agronomy and pathology each. The project has also trained a number of farmers on good agricultural practices (GAP) and seed production in malt barley – 160 farmers and sorghum – 150 farmers.

iv) **Malt barley production.** The project produces all the breeders' seed to facilitate the production of malt barley – a total of 30-40 tons every year . This seed is used to produce barley for brewing by many farmers in Njoro, Mau Narok, Timau and Uasin Gishu (Moiben) regions. More than 400 barley farmers are involved in this activity. We have also been involved in soil sampling, testing and recommendations to facilitate fertilizer use efficiency in barley production.

v) **Extension and outreach**

The project participates in these activities especially barley field days, most of which are held in Mau Narok; where we explain barley crop husbandry and any new varieties entering production cycle. These organized together with the Cereal grain growers association and agrochemical industry. Similarly we participate in the Agribusiness Trade Fair organized by the University of Eldoret

vii) **Research papers published**

❖ Javan Omondi Were, **Julius Onyango Ochuodho**, Nicholas Kipkemboi Rop and Sanjaya Gyawali (2020). Rapid Screening Method for Tolerance to Aluminium Toxicity in Barley: Case Study on Commonly Grown and Newly Bred Genotypes in Kenya. International Journal of Plant Breeding and Genetics, 14 (1): 1-8; ISSN 1819-3595 DOI: 10.3923/ijpbg.2020.1.8

❖ Kipkogei Chemitei, Makumba B. Amendi, Lizzy A. Mwamburi, **Julius Onyango Ochuodho** (2019). Bio-Control of Net-Blotch and Scald Pathogens of Barley Using *Paenibacillus Polymyxa* KAI245 Isolated from Sorghum Rhizosphere in Western Kenya. American Journal of Microbiological Research, 2019, Vol. 7, No. 1, 28-36

- ❖ Nadir S. Waluchio, Caleb O. Othieno, Wilson K. Ng'etich and **Julius O. Ochuodho** (2015). Evaluation of Nitrogen Fertilizer and Lime on Grain Yield, Protein Content and Kernel Weight of Barley (*Hordeum vulgare* L.) in Kenya. *International Journal of Plant & Soil Science, 8(4): 1-7, 2015; Article no.IJPSS.6239 ISSN: 2320-7035*
- ❖ Javan Omondi Were, **Julius Onyango Ochuodho** (2014). Sensitivity of Barley (*Hordeum Vulgare*) to Phosphate Fertilizer Formulations under Acidic Soils in Kenya. International Journal of Research Studies in Biosciences (IJRSB) Volume 2, Issue 6, July 2014, PP 50-59 ISSN 2349-0357 (Print) & ISSN 2349-0365 (Online)
- ❖ Abigael Adhiambo Owino, **Julius Onyango Ochuodho**, Javan Omondi Were and Nicholas Rop (2014). Response of spring and winter barley to *Pyrenophora teres* under high and medium altitude zones of Kenya. International Journal of Research In Agriculture and Food Sciences Vol. 2, No.2: 1-10   June. 2014 ISSN 2311 -2476
- ❖ Abigael A Owino, **Ochuodho JO** and Javan O Were (2013). Morphological diversity of net blotch fungi (*Pyrenophora teres*) infecting barley in barley growing areas of Kenya. Journal of Experimental Biology and Agricultural Sciences, December - 2013; Volume – 1(6). **ISSN No. 2320 – 8694**

7. Wheat and Dolichos Varieties Research at UOE

Prof Miriam Gaceri Kinyua has been conducting very successful research projects towards production of novel varieties of cash and food crops in Kenya. Prof. Kinyua who is an alumni of University of Nairobi where she did her BSc., MSc., and PhD. She is a recipient of Presidential award **Order of the Grand Warrior** for contribution to food security through research. Before joining the University of Eldoret, Prof Kinyua was involved in research at KARI (now KALRO) where she developed and released over 10 varieties. Following her outstanding research, she has mentored over 20 students supervised for MSc and PhD degrees.

Wheat Research

The initial research projects, focused in the development of wheat varieties resistant to Stem rust *UG99* leading to release of 2 varieties ELDO BARAKA and ELDO MAVUNO. The beneficiaries of these innovations include wheat farmers in Kenya and East Africa

region, wheat millers and other agro-processing industries, consumers of wheat products and policy makers. The project was sponsored by International Atomic Energy Agency

a) Eldo Mavuno at a farmers field in Narok b) Seed crop at UoE farm

The project produced 3 Phd students: Philip Chemwok, Paul Kimurto and Alice Ndiema and 3 MSc. students: Amos Ego, Gerald Githinji, and Philis Njane2

Dolichos Research

The objective of this research was to develop *Dolichos lablab* varieties with farmer and consumer preferred traits, from the existing landraces and local cultivars using various breeding methods including mutation techniques, conventional breeding and biotechnology. Selections were made and 4 varieties were released namely Eld KT black 1, Eldo KT black 2, Eldo KT Cream and Eldo KT Maridadi. Certified seed has been grown and sold to farmers in all major growing areas, and in Tanzania. Beneficiaries include dolichos farmers with improved seeds, consumers, agroindustry and policy makers. This project produced 2 PhD graduates: Grace Kamotho and Naftali Ondabu.

The release of four (4) Dolichos varieties in Kenya is a culmination of research work spanning eight years and supported by KT. **ELDO-KT Black 1, ELDO-KT black 2, ELDO-KT cream and ELDO-KT Maridadi were released for commercial production in Kenya in February 2015 (Kenya-Gazette notice no. 313 of 2015 (Feb 2015). Certified seed are available for these varieties for planting.** The work to develop improved Dolichos lablab started with a survey in 2005 of *Dolichos* bean growing areas in Kenya. Selections were made from all collections based

on their desirable traits. Other germplasm was sourced from the Gene Bank of Kenya collections. A cross-breeding programme was initiated with 10 selections, in half-diallel pattern. From the segregating populations, advanced through pedigree method, 16 selections were identified at F4. Four selections were made from a mutant population. These were further reduced to 10, and finally, 6 were entered into the National Performance Trial (NPT).

In September 2014, four entries, B1, M1, W7 and LG1 were recommended for release by the NPT committee. On February 4th 2015, the National Variety Release Committee announced the release of the four with release names ELDO – KT black (1 and 2), ELDO-KT cream and ELDO-KT Maridadi. Some of the outstanding features of these varieties are early to medium maturity, uniform to variable maturity type, determinate to semi-determinate growth habit, black, cream and spotted grain colors with purple, pink and white flower colors; providing a wide choice among the diverse demands by small scale farmers and consumers. The seed is being multiplied by University of Eldoret for the farmers and the results from this project is positively and greatly impacting on food security and income generation among small scale farmers in Kenya.

Left: Mature Dolichos plant, Right: Dolichos in large scale field trials in Meru County.

Young scientists have been effectively prepared to be future celebrated breeders. Equipping of the lab has provided much needed facilitation for breeding in modern times. A total of 6 MSc

and 4 Ph.D students were trained as well as several others supported for in the course of their studies.

The *Dolichos* research outcome has been disseminated through different channels including publication of 9 articles in International peer reviewed journals, over 10 conference papers and 1 book on *Dolichos* breeding published in 2012. All these form appreciated outputs from the project. Below are some of the publications from the research.

Publications

- Boit, L.C; **M. Kinyua**, O. Kiplagat, E. Chepkoech (2018). Evaluating Kenyan Dolichos (Lablab purpureus L.) Genotypes for Resistance to Legume Pod Borers (Maruca vitrata and Helicoverpa armigera) Using Morphological Markers. International Journal of Plant Breeding and Crop Science Vol. 5(1), pp. 344-351, March, 2018. ISSN: 2167-0449

- Grace N. Kamotho, Reuben M. Muasya, **Miriam G. Kinyua**, (2017). Assessment of phenotypic diversity of Kenyan dolichos bean (Lablab purpureus l. Sweet) germplasm based on morphological markers. International Journal of Agriculture, Environment and Bioresearch Vol. 2, No. 06; 2017 ISSN: 2456-8643

- Kamotho, Grace; G. Kinyua, Miriam; M. Muasya Reuben; Gichuki, Simon; Wanjala, Bramwel; Kimani, Esther and N. Kamau, Eliezah. (2016). Assessment of genetic diversity of Kenyan dolichos bean (lablab purpureus l. sweet) using simple sequence repeat (SSR) markers

- Kamotho G.N., Kinyua M.G and R.M Muasya (2015) . Evaluation Of Performance Of Dolichos Bean (Lablab Purpureus (L.) Sweet) Under Different Agro-Ecological Environments In Kenya. Research Journal of Agriculture.Vol. 2 No. 9

- Kimani E. N., F. N. Wachira and M. G. Kinyua (2012). "Molecular Diversity of Kenyan Lablab Bean (Lablab purpureus (L.) Sweet) Accessions Using Amplified Fragment Length Polymorphism Markers," American Journal of Plant Sciences, Vol. 3 No. 3, 2012, pp. 313-321. doi: 10.4236/ajps.2012.33037

- Shivachi A, Kinyua M.G, Kiplagat K.O and Kimurto P.K, & Towett B.K. (2012). Cooking time and sensory evaluation of selected Dolichos (Lablab purpureus) genotypes. 2012. African Journal of Food Science and Technology; 3(6) 24-32

- Kimani E., F. Wachira, M.Kinyua , J .Matasyoh (2011). Biochemical analysis of cassava quality traits in central rift Characterization of volatile compounds of Kenyan lablab Bean (lablab purpureus) accessions and their flavour Attributes.

- Kamau E.M., M. Kinyua, O. Kiplagat and L. Gohole (2011). Gamma Radio Sensitivity Determination for Lablab (Lablab purpureus) Bean. Plant Mutation Reports Vol.2 No.3

❖ Kamau E. M., M. G. Kinyua, L. Gohole, O. Kiplagat (2011). Screening Of Local Lablab Accessions For Resistance To Cow Pea Aphid. East African Agricultural and Forestry Journal, Vol 77, No 1&2

❖ Kamotho G. N., Kinyua M.G., Muasya R. M., Orwa D. O., Kimani E. N.(2010) Baseline Survey on Production Practices, Constraints and Utilization of Dolichos Bean in Kenya: Implications for Dolichos Bean Improvement. International Journal of Professional practice

8. **University Develops Unga Nutritious Brand**

Prof. Violet Mugalavai is the innovator behind Unga Nutritious Brand being hosted at the Food Processing and Incubation Centre in partnership with Purdue University of United States. The instant flour (Unga Nutritious) is an innovation which only requires hot water to prepare a meal of Ugali and porridge. This innovation aimed at curbing post-harvest losses among smallholder farmers subjects the flour into an intense preparation process, where the flour is also fortified with fruits, cereals, and vegetables depending on the user's preferences.

This inventiveness has created a positive impact on by Expanding sorghum and millet markets in urban/rural Kenya through application of food technology, Improved nutritional quality of food products, Enabled a market-pull for food fortification, support Entrepreneurship, Embrace science and technology and local knowledge, Train and incubate potential entrepreneurs, Foster partnerships with key entrepreneurs, Push and Pull for fortified crops in real consumer products and Look for opportunities for changes in products to meet nutrient needs in Unique ways.

Unga Nutritious product comes in two varieties; Instant Ugali Pap and Instant Porridge Pap which have been licensed by the Kenya Bureau of Standards (KEBS) and currently, modalities are being put in place to patent the product. The initiative allows people who are lovers of ugali and porridge to be able to instantly prepare their meals on the go by using hot water. Kenya loses up to Ksh. 150 billion

worth of food after every harvest season as millions of Kenyans grapple with starvation due to drought. This innovation will come in handy in addressing such issues as it utilizes harvested products such as maize, sorghum, amaranth grains, millet, chickpeas, cowpeas, baobab, rice, cassava, sweet potato, carrot, pumpkin, bananas, and even mangoes. The Food Processing and Incubation Centre established through this project at the University is also a hub for innovative ideas in food processing, and it has also brought on board students from other Universities who are working at the center on attachment basis.

Prof. Violet K. Mugalavai holds a Ph.D in Human Ecology (Food, Nutrition and livelihood Security) from Moi University; M.Ed Home Economics, and B.Ed Home Economics, both from Kenyatta University. She is an Associate professor in the Department of Family and Consumer Sciences, School of Agriculture at the University of Eldoret. Previously she served as the Head of Department and the Director of Industrial Linkages, Partnerships and Collaborations. Her areas of research interest include Food Science, Nutrition, and Postharvest handling (value addition using food to food fortification). Currently she is engaged in 2 research projects including *Sustainable Reductions of Post-Harvest Losses in Feed the Future Countries Through Technologies and Innovations that Links Farmers to Markets, a USAID funded project for the Food Processing Innovation Lab.---Phase 2 and Sustainable Post-Harvest and Agro-Processing Technologies for Improved Livelihoods among Rural Communities in Elgeyo Marakwet County, Kenya.* **The** projects are targeting SDGs number 2 (ending hunger, achieve food security and improved nutrition and promote sustainable agriculture; and number 12 (ensure sustainable consumption and production patterns), among others.

I these research projects she collaborates with Purdue University, USA(Lead Project Institution), North Carolina State University, USA, University of Pretoria, South Africa, CIMMYT Kenya, ITA Senegal, KALRO Kenya, and Rongo University (Lead NRF Institution)

Achievements:
i.   The project has established a Food Processing Training & Incubation Center (FPTIC) at the University of Eldoret, that trains women and the youth in cereal processing using food to food fortification value addition mechanisms with the aim of curbing postharvest losses in communities and thus creating a market-pool of nutritious cereal flours for both thin *(uji)* and thick *(ugali)* porridge. The project has thus given the youth an arena to innovate various composite flours in different brands and empowered them to start their own enterprises towards providing consumers with nutritious flour alternatives for all age groups and for better health outcomes.

ii. The project innovated **"UNGA NUTRITIOUS"** which is a natural extruded wholemeal instant flour made out of neglected cereal crops and fortified using food to food approaches to enable reduction of postharvest losses. The flour can make both thin *(uji)* and thick *(ugali)* porridge and offers better nutrition alternatives to consumers to reduce malnutrition whereas offering a clean and convenient alternative by reducing time taken and the stress that goes with the longer traditional methods of preparation.

iii. The project has come up with innovations in solar drying, grinders and moisture meters to enable reduction of postharvest losses through spoilage of fruits, vegetables and cereals in Feed the Future Countries.

Publications:

The following publications have been generated as a result of this research project:

- ❖ *Mugalavai, V. K., Aduol, K. O., & Onkware, A. O. (2021).* Nutritional Characteristics of Rice (Oryza sativa L.) Composite Flours Obtained by Food Fortification. *European Journal of Agriculture and Food Sciences*, *3*(1), 79-83. https://doi.org/10.24018/ejfood.2021.3.1.224

- ❖ *Violet K.Mugalavai, Josiah O. Oyalo & Augustino O. Onkware (2020).* Characterization of the Nutritional Properties of Sorghum Composite Flours Using Different Food to Food Fortification Approaches. EJFOOD, European Journal of Agriculture and Food Sciences Vol. 2, No.6, November 2020. DOI: http://dx.doi.org/10.24018/ejfood.2020.2.6.84

- ❖ *Sanya Emmaculate, Okoth M. Wandayi, Abong' G. Ooko & Mugalavai V. Kadenyeka(2020).*
- ❖ Nutrient and Anti-Nutrient Composition of Extruded Cereal Flours Fortified with Grain Amaranth, Baobab and Orange-fleshed Sweet Potato Powder. Journal of Food Research; Vol. 9, No. 6; 2020 ISSN 1927-0887 E-ISSN 1927-0895 Published by Canadian Center of Science and EducationReceived:July21, 2020Accepted:September1, 2020Online Published: October6, 2020

- ❖ URL:https://doi.org/10.5539/jfr.v9n6p21.

- ❖ *Sanya Emmaculate, Okoth Michael Wandayi., Abong George Ooko and Mugalavai Violet Kadenyeka. (2020).* "*Consumers' acceptability of extruded maize-sorghum composite flours fortified with grain amaranth, baobab and orange fleshed sweet potatoes.*" *African Journal of Food Science 14, no. 9 (2020): 274-284.* https://doi.org/10.5897/AJFS2020.1996. https://academicjournals.org/journal/AJFS/article-abstract/B64B72564932

- ❖ *Mugalavai Violet K., Mutinda Victoria, Kevin O. Aduol, Josiah Oyalo, & Onkware Augustino O.(2020).* Sensory evaluation and consumer acceptability of Snack Value-Added Rice Products in Eldoret Town, Kenya*IOSR Journal of Humanities And Social Science (IOSR-JHSS) Volume 25, Issue 7, Series 16 (July. 2020) 51-57 e-ISSN: 2279-0837, p-ISSN: 2279-0845. www.iosrjournals.org.* https://doi.org/10.9790/0837-2507165157

- ❖ *Mugalavai, Violet K. & Omutimba, Harriet N.O.(2020).* Consumer contextual socialization and decision making on consumption of African leafy vegetables among university youth populations. International Journal of Scientific and Research Publications, Volume 10, Issue 6, June 2020 1010 ISSN 2250-3153. http://dx.doi.org/10.29322/IJSRP.10.06.2020.p102122

- ❖ *Chepwambok, L.; Adede, W. O.; Mugalavai, V.K.; Onkware, A.O. (2020).* Utilization of post-harvest technologies for improved food security: case of maize and mangoes among

smallholder farmers in Kerio valley, Kenya. DOI: 10.46609/IJAER.2020.v06i03.010 URL: https://doi.org/10.46609/IJAER.2020.v06i03.010

❖ *Toroitich, Caroline, Mugalavai Violet, & Ochuodho Julius (2020).* Influence of household socio-demographic characteristics on food security status of small-holder farmers in Uasin Gishu County, Kenya. **DOI:** 10.46609/IJAER.2020.v06i02.012 **URL:** https://doi.org/10.46609/IJAER.2020.v06i02.012

❖ *Mugalavai, V.K. (2020).* Exploring Home-use Test to Assess Urban Consumers' Acceptance and Likelihood to Purchase Naturally Fortified Instant Whole Meal Sorghum-maize Flour Blends in Eldoret, Kenya. J*ournal of Food Research;* Vol. 9, No. 3; 2020 ISSN 1927-0887

❖ E-ISSN 1927-0895 Canadian Center of Science and Education. https://doi.org/10.5539/jfr.v9n3p19

❖ *Ouma, R.O, Mugalavai, V.K & Onkware, A. O (2020).* Market Survey on Adoption and Utilization of Post-Harvest & Agro Processing Technologies in Uasin-Gishu County, Kenya; International Journal of Scientific and Research Publications (IJSRP) 10(05) (ISSN: 2250-3153), DOI: http://dx.doi.org/10.29322/IJSRP.10.05.2020.p10147

❖ *Toroitich Caroline, Mugalavai Violet, & Ochuodho Julius (2020);* Effect of availability, access and utilization of agricultural extension technologies on the food security situation of smallholder farmers in Uasin Gishu County, Kenya. International Journal of Scientific and Research Publications (IJSRP) 10(05) (ISSN: 2250-3153), DOI: http://dx.doi.org/10.29322/IJSRP.10.05.2020.p10171

❖ *De Groote, Mugalavai V, Mario Ferruzzi, Augustino Onkware, Emmanuel Ayua, Kwaku G. Duodu, Michael Ndegwa, and Bruce R. Hamaker (2020).* Consumer Acceptance and Willingness to Pay for Instant Cereal Products with Food-to-Food Fortification in Eldoret, Kenya https://doi.org/10.1177/0379572119876848 journals.sagepub.com/home/fnb

❖ *Kipyego, R & Mugalavai, V.K (2019).* The Nexus of Drought Tolerant Crops and Food and Nutrition Security among Smallholder Farmers In Kerio Valley, Elgeyo Marakwet County, Kenya. International Journal of Scientific and Research Publications, Volume 9, Issue 9, September 2019. ISSN 2250-3153. DOI: 10.29322/IJSRP.9.09.2019.p9354

❖ *Mugalavai V.K., Onkware A. O., Omutimba, H.N, & Oyalo, J. (2019).* Exploiting the Nutritional Profile and Consumer Behavior on Choice and Utilization of Selected Sorghum Varieties in Western Kenya. International Journal of Science and Research (IJSR) ISSN: 2319-7064.

❖ *Mugalavai, V. K., Oyalo J., Ayua E., & Onkware, A. O.* (2019). Measuring Consumer Interest in Sorghum Composite Flours in Western Kenya. International Journal of Scientific and Research Publications, Volume 9, Issue 7, July 2019 369 ISSN 2250-3153DOI: 0.29322/IJSRP.9.07.2019.p9149 http://dx.doi.org/10.29322/IJSRP.9.07.2019.p9149.

❖ *Mokeira, W.M. & Mugalavai V. K (2019).* An assessment of knowledge, attitude and practices of daily water intake among undergraduate students in University of Eldoret, Kenya. International Journal of Agriculture and Environmental Research, vol. 5, no. 4, 2019, pp. 490-501. July-August, ijaer.in/ **ISSN 2455-6939**

❖ ***Evusa G. V. & Mugalavai, V. K. (2019)****. Nutritional Composition of Species in the *vernonia hymenolepis* Complex in Kenya. International Journal of Scientific and Research Publications, Volume 9, Issue 5, May 2019 242 ISSN 2250-3153. DOI:10.29322/IJSRP.9.05.2019 .p8927.http://dx.doi.org/10.29322/IJSRP.9.05.2019.p8927.