GOVERNMENT OF UGANDA

MAKERERE UNIVERSITY

Makerere University Research and Innovations Fund; Contribution to the Sustainable Development Goals

November 2021

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1.0. INTRODUCTION

The Sustainable Development Goals (SDGs), also known as the Global Goals, were adopted by the United Nations in 2015 as a universal call to action to end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity. The 17 SDGs are integrated and recognize that action in one area will affect outcomes in others, and that development must balance social, economic and environmental sustainability. All over the world, countries have committed to prioritize progress for those who are furthest behind. The SDGs are designed to end poverty, hunger, AIDS, and discrimination against women and girls. Creativity, know-how, technology and financial resources from all of society are necessary to achieve the SDGs in every context. These goals are compressed into the 5Ps of People, Planet, Peace, Prosperity and Partnerships

1.1. Government of Uganda's commitments to advance Research for development

Research universities in low- and middle-income countries have crucial roles to play in developing differentiated and effective academic systems, and in making it possible for their countries to join the global knowledge society and compete in sophisticated knowledge economies. Makerere University is on the path to becoming a research-led university. With funding from the Government of Uganda in 2019 to date, Makerere University created a Research and Innovations Fund (Mak-RIF) to support high-impact Research and Innovations that inform National development priorities. The fund illustrates the increasing importance that the Government attaches to Research and Innovation as catalysts to Uganda's march towards Middle Income Status and attainment of the National Development Plan, the Vision 2040 and Sustainable Development Goals of 2030. The objective of this fund is to increase the local generation of translatable research and scalable innovations that address key gaps required to drive Uganda's development agenda, especially the un-funded priorities. In this report, we highlight the contribution of Makerere University towards achievement of the 17 Sustainable Development Goals through the various projects funded by the Government of Uganda.

2.0. MAK-RIF Funded Projects and The Sustainable Development Goals

Sustainable Development Goal 1; Zero Poverty

This goal targets to reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions by 2030. Progress has also been limited in sub-Saharan Africa and Asia, which account for 80 percent of those living in extreme poverty. Most of the projects included in this report indirectly contribute to this Sustainable Development Goal.

It is worthy to note that all the projects highlighted in this report contribute to the attainment of the sustainable development goal one through economic empowerments, equal opportunity, skills development among others.

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Sustainable Development Goal 2; Zero hunger

Unfortunately, extreme hunger and malnutrition remain a huge barrier to development in many countries. The SDGs aim to end all forms of hunger and malnutrition by 2030, making sure all people–especially children–have sufficient and nutritious food all year. There were 821 million people estimated to be chronically undernourished as of 2017, often as a direct consequence of environmental degradation, drought and biodiversity loss. Professor Johnny Mugisha and Dr Francis Okori have led research teams focusing on reduction of food wastage in turn ending hunger and malnutrition as highlighted below;

Enhancing Value addition on Potato-Sorghum enterprises for Improved Livelihoods in Uganda; Johnny Mugisha

Target addressed; **2.3** By 2030, double the agricultural productivity and incomes of small-scale food producers.

Prof Johnny Mugisha from the College of Agriculture and Environmental Studies pioneered a project focused on enhancing physical, economic and nutrition value of potato (*Solanum tuberlosum*) and sorghum (Sorghum bicolar) in Uganda with interest in South-western region. Potato and sorghum are the region's main enterprises. However, they compete for farm resources, and in terms of household food, they are neither substitutes or complements.

Objective; The overall objective of the project was to improve the economic value of potato and sorghum enterprises for improved livelihoods of the value chain actors. Specifically, the project developed, tested and validated innovative potato-sorghum based value-added products with potential for commercialization; and finally determined the economic viability and market potential of the validated products in a competitive food market.

Outputs; The project was able to develop a range of high-quality potato-sorghum based products including cookies, biscuits and waffles. By providing another alternative to the potato (especially the tiny tubers) and sorghum, farmers in the potato growing regions were motivated to pursuit growing potato. In addition, farmers were investing as entrepreneurs in value addition and commercialisation of the developed products in order to enhance their incomes and diversify their activities.

On-farm comparative evaluation of hermetic and conventional storage technologies on post-harvest quality of stored common beans: Francis Okori

Objective: To evaluate the technical performance, profitability, and constraints to the adoption of four hermetic storage technologies against the conventional woven polypropylene (PP) bags for the storage of common beans on grain quality.

Output: Bean cultivar: A local bean cultivar commonly grown in Northern Uganda and susceptible to bruchids was used. Naturally infested beans without any synthetic or local pesticides were bought from a local grain trader in Awindiri market, Adjumani town.

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Treatments: Four hermetic storage technologies (HSTs) were investigated for the storage of dry common beans for six months. These were:

1) Purdue Improved Crop Storage (PICSTM) bag (100kg);

2) SuperGrain bag (100kg);

3) Metal silo (100kg); and

4) Plastic silo (100kg).

These were compared against the conventional woven polypropylene bag as a control.

Each of these five treatments was used for bean storage under two circumstances: 1) Naturally infested, and 2) Artificially infested beans

Contribution to SDG: There is/will be reduced post-harvest storage losses in the study area hence improved food security and household income. Besides, the project has provided a trajectory towards Vision 2040 and SDGs of zero Hunger and No Poverty for the Community of Adjumani district and West Nile in general.

Sustainable Development Goal 3; Good Health and wellbeing

This goal was developed to ensure healthy lives and promote wellbeing for all at all ages. Mak-RIF has funded research and innovations to test possible solutions to eradicate a wide range of diseases and address many different persistent and emerging health issues as detailed below;

Advancing Tissue and Organ bio-banking in Uganda; Prof. Joloba Moses

Target addressed: 3.7 By 2030, ensure universal access to sexual and reproductive health-care services, including for family planning, information and education, and the integration of reproductive health into national strategies and programmes.

Prof. Moses Joloba from the College of Health Sciences built capacity for organ and tissue bio-banking. The team has pioneered bio banking in Uganda by establishing the first well-annotated, quality assured biorepository for nucleic acids, blood, and its derivatives with over 100,000 samples in storage over the last 10 years. Basing on this success, the multidisciplinary team expanded the scope to tissue and organ bio banking, starting with sperm, ovum, and umbilical cord blood.

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Testing a Community-based Ultrasound Scan system during early and late antenatal care to facilitate gestation age dating, referral and preterm care in low resource districts in Eastern Uganda by Prof. Peter Waiswa

This project contributes to target 3.1: By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births by testing the effectiveness of use of ultrasound during early and late antenatal care or labour to facilitate gestation age dating, referral and preterm care in Luuka, a rural Ugandan district

Outputs: A pre-post evaluation study was designed to extend ultra sound scan services through routine outreach programs and community health workers volunteer systems to reach low resource areas. Clinical assessment and decision-making was done after obstetric scan and focusing on detection of high-risk obstetric conditions such multiple gestation, mal-presentation, oligohydramnios, placenta previa, gestational age<37 weeks, and foetal heart rate abnormalities. Study participants received the first scan between 24 and 28 weeks and a follow-up scan was planned after 37 weeks. Mothers with these complications were referred for appropriate management and followed up until delivery. Additionally, we trained 55 Village health teams members to identify, register and refer pregnant women for scanning, Refurbished un-utilized rooms into Ultrasound scan rooms with equipment, furniture and accessories, Operationalized ultrasound scan services at the Health Centres of Kiyunga and Bukoova.

Contributions to SGD3: The project demonstrated that it is possible to run Ultrasound scan services at lower level health centres and early detection of pregnancy complications is possible in low-resource health facilities.

Leveraging on technology to reduce cardiovascular-metabolic risk among patients with diabetes mellitus in a resource limited setting, Mulago Hospital: A randomized controlled trial: Edrisa Ibrahim Mutebi

Goal 3 Target addressed: 3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being by evaluating the caloric values of selected locally available foods, assessing their glycaemic indices for selected locally available foods and determining the cardiovascular-metabolic benefits of a closely monitored pre-set exercise plan and dietary regimen.

Outputs:

The study came up with the caloric content of different carbohydrate-based foods. These were ranked in the following order of caloric content: Chapati, bread, cassava, sweet potatoes, rice posho, millet, Irish potatoes, matooke. Matooke and Irish potatoes will give the lowest glycaemic response while chapati and cassava will give the highest response among the foods.

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The higher the caloric content, the greater the glucose rise after ingestion of the food.

Caloric reduction of 35% with 10,000 steps per day or exercises for 150 minutes per week by patients living with Diabetes Mellitus led to a significant change in the mean (SD) BMI 2.33 (1.39) and mean (SD) HBA1C 2.48 (1.41). These, in the long run, lead to control of the DM and reduction in the complications.

A Mobile Health Individualized Dietary Plan and Behavioral lifestyle tracker for Diabetics in Uganda; Alice Mugisha Nandawula

Objective; To develop a mobile health (mHealth) individualized dietary plan and behavioral lifestyle tracker for addressing nutrition challenges and improving behavioral lifestyles for diabetics in Uganda

Outputs; The application development framework which incorporates the three principles; Behavioral Change Theories, User Centered Design (UCD) and Social Marketing, guided the development of this mobile application. Behavioral Change Theory based on the health belief model was used to evaluate personal factors that may be influencing health behaviors.The App has been deployed on the android Google play store for free download and installation but also can be accessible through an internet web browser from an ordinary computer. The release name in play store is mDiabetesUG

Contributions to SDG3: The project will affect the way the health care system manages patients with Diabetes mellitus. It will provide the patients with all the knowledge about the different local carbohydrate-based foods. This will enable them to control their DM better through diet. The clinicians who are involved in the treatment of patients with DM will have adequate data about the foods and their caloric contents; they will therefore be in a position to advise their patients better about diet and control of DM. The ministry of health will be in a position to use the data in the development of policies about exercises and caloric reduction in the management of DM. These will in the long run reduce morbidity and mortality attributable to DM.

Developing Monitoring System for Quantifying and Mapping antibacterials used in Livestock Farming Systems in Uganda; Prof. Lawrence Mugisha

Antimicrobial Resistance (AMR) is one of the top three challenges faced by mankind today after Climate change and terrorism. The consumption of antimicrobials is a leading cause of antimicrobial resistance (AMR).

Objective; To develop an Information Technology (IT) System for reporting antimicrobial quantities imported, distributed and used in livestock production systems in Uganda to inform surveillance and management of Antimicrobial Resistance (AMR)

Output; The team conducted a study to establish the national consumption data of antimicrobials used in livestock production systems and to develop an information technology (IT) monitoring system for reporting antimicrobial quantities imported, distributed and consumed. The system is able to display

antimicrobial data for animal use from import data to an IT dashboard visualised by regulators and policymakers in simplified formats. The data is extremely important to monitor antimicrobials imported and eventually used in different livestock. The data can be used to predict the antimicrobials being overused and likely to contribute to the development of resistance.

Sustainable Development Goal 4; Quality Education

Since 2000, there has been enormous progress in achieving the target of universal primary education. The total enrolment rate in developing regions reached 91 percent in 2015, and the worldwide number of children out of school has dropped by almost half. There has also been a dramatic increase in literacy rates, and many more girls are in school than ever before. These are all remarkable successes.

Skills Matching, Wages and Productivity gains: Creating a Competitive Advantage for Ugandan Youth in the Labour Market

The increased investment in education has led to a constant increase in the average level of education of the Ugandan labor force. However, despite the increase of resources devoted to education, Uganda has still failed to get full return on investment in education. This can partly be attributed to the inadequate technical skills possessed by the students from the education and training systems that do not match those demanded in Uganda's labor market which is commonly referred to as skills-mismatch.

Objective: To explain the relevance of skills matching in bridging wages differentials and enhancing productivity, with particular attention paid to the youthful labor force in Uganda.

Contribution to SDG: Employers have continuously raised the challenge of the increasing skills mismatches. This hampers productivity growth and economic growth at both firm level and the economy at large. Dr Joweria Teera from the College of Business and Management Sciences provided evidence that Policies to alleviate skills mismatch are critical for bridging wage differentials and productivity differences while ensuring increased and gainful employability of youth.

Resilient Communities for Quality Primary Education in Uganda (ReCoPE)

The Uganda Government's commitment to achieve SDG-4 on Quality Education has been tremendous through investment in Universal Primary Education (UPE). However, out of the 2,159,850 who enrolled in P1 in 1997, approximately 22% reached P7 in 2003 and 29% in 2004. The completion rate in 2011 was 67% but dropped to 62% by 2017 (NPC 2018). The fluctuation was partly attributed to the dismal participation of parents in their children's education.

Objective; to improve the quality of primary education in Uganda through the development of a community-led support system that enhances the resilience of both male and female parents and the wider community to effectively participate in children's learning. Through discussions, the project has raised the consciousness of parents, teachers, community members, and identified gaps in parental involvement and how to act to fill them using the key messages developed through dialogue with the community. The project trained/capacitated 150 change agents in Mayuge and Nakaseke district with skills and knowledge on how to engage communities/parents in their children's learning

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Pedagogical Leadership for Academic Staff in Higher Education Institutions to Enhance Graduate Work Readiness and Transition to Work (PLASHE-WIL): Ronald Bisaso

Objective: To develop the capacity of academic staff in Pedagogical Leadership and Work-Integrated Learning to enhance graduate work readiness and transition to work competence development

Output: A Post Graduate Diploma in Higher Education Pedagogy that embeds Work-Integrated Learning has been proposed and piloted among stakeholders drawn from public and private universities as well as agencies. The programme will develop capacities of academic staff to sustainably integrate graduate work readiness and transition to work skillsets.

Contribution to SDGs (4 and 8): The developed PLASHE-WIL Post Graduate Diploma Programme explicitly embeds Work-Integrated Learning which is critical for creating a critical mass of pedagogical leaders who can competently integrate graduate work readiness and transition to work skills in the degree programmes, teaching and assessment.

Using Emerging Technologies to Innovate the Teaching and Learning of History in Public Universities in Uganda (eHistory): Harriet Nabushawo

Objective: To revive the teaching of History in higher institutions of learning in order to make it more interesting to students and also reposition its relevance for national development.

Output: Guiding principles for using ICT-enabling pedagogy for teaching and learning History were developed using the Education Design Based Research (EDBR) that combines research, design and practice.

Contribution to SDGs (4 and 17): The eHistory Project contributed towards innovations in teaching humanities using emerging technologies. The project also contributed to building collaborations among universities.

The project contributed to repositioning the role of History in social-cultural cohesion and building the spirit of patriotism as a basis for national development

Digitization of Land Archival Documents in Makerere University Library (1830-1995): Rhoda Nalubega

Objective: To preserve and promote access to land archival records of Makerere University which were at a risk of deterioration/eminent danger

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Output: This research project digitized land archives that are part of the 238 boxes of archival materials embedded in Buganda government archives 1831-1977 and Uganda protectorate government archives 1880-1992 accommodated at Makerere University Library. The land archives in question comprise titles, Lukiiko minutes and correspondences, treaties and testamentary practices at Makerere University Library, Africana section. The Africana section doubles as the host for special collections and the national reference library. It hosts collections on/by/about Uganda, Africa, UN depository, music archive, audio-visual collections, newspapers, microfilms, and paper archives. This project focused on the land archives which are a portion of the paper archives.

Contribution to SDGs (4 and 9): The project enhanced the availability and access of land archival documents for the period 1830-1995. The project also has played the role of sensitizing stakeholders about the availability and access of land archival documents in Makerere University

The Transactional Law Clinic: Phiona Muhwezi Mpanga

Objective: The overall objective of the intervention is to enhance the appropriateness and relevance of legal education and practice in addressing the legal needs of indigent persons, low income earners, and not-for-profit business ventures through the use of clinical methods of teaching and setting up a legal aid clinic to support these communities.

Output: The project in this initial year targeted 12 law students drawn from the third and fourth year of study to learn various aspects of commercial law using clinical methods and journal their learning experience; 47 academic staff at the School of Law to receive training in using clinical methods of teaching. Three clients willing to partner with the Clinic included two social innovation enterprises, the Social Innovation Academy and United Social Ventures; and one community of informal traders under Platform for Vendors in Uganda (PLAVU) all of which provided practical learning experiences for the students under close supervision. The experiences of the pilot have been documented through students' reflective journals, activity reports, client satisfaction surveys and later a manual developed to advise on how best to establish and run such a clinic in a university setting.

Contribution to SDGs (4): Under the pilot, law academics teaching commercial subjects were introduced and interested in changing the way they instruct learners. They were made to appreciate the use of clinical methods in the teaching and learning of the commercial law subjects under the LLB programme. The pilot also provoked debate on pedagogical issues especially for law academics who generally do not have a background in pedagogy. The pilot also initiated collaborations and networking between law schools on matters of pedagogy and innovations. A case for revolutionizing the teaching of commercial subjects has been made and advocacy on the same in the different universities kick-started.

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Sustainable Development Goal 5; Gender Equality

Ending all discrimination against women and girls is not only a basic human right, it's crucial for sustainable future; it's proven that empowering women and girls helps economic growth and development. Currently, there are more girls in school now compared to 15 years ago.

Enhancing Capacities of Women to Leadership Positions in Universities in Uganda (WOLEP); Florence Nakamanya

Objective; To identify the capacity needs and what works for women to occupy leadership positions in universities in Uganda

Output; Through the initiative, there are more women willing to occupy and aspire for leadership positions in Ugandan universities. A document on women's experiences with the existing leadership programmes and how they influence their aspirations and progression to leadership in Ugandan Universities. With such evidence availed, we believe more women will aspire and progress to leadership. From our findings, we also developed a Post Graduate Certificate in Gender and Leadership in Higher Education.

This contributes to Target 5.1 and 5.5 of the SDG 5 that seeks to End all forms of discrimination against all women and girls everywhere and Ensure women's full and effective participation and equal opportunities for leadership at all levels of decisionmaking in political, economic and public life.

Sustainable Development Goal 6; Clean Water and Sanitation

More and more countries are experiencing water stress, and increasing drought and desertification is already worsening these trends. By 2050, it is projected that at least one in four people will suffer recurring water shortages. Safe and affordable drinking water for all by 2030 requires we invest in adequate infrastructure, provide sanitation facilities, and encourage hygiene. Protecting and restoring water-related ecosystems is essential.

Building Stewardship and Resilient Ecosystems through Participatory Integrated Planning Approaches. The Case of Manafwa Watershed, Eastern Uganda

This project led by Dr. Frank Mugagga focused on the Manafwa watershed in Eastern Uganda, which covers part of the Mount Elgon National Park, and is impacted by increasingly frequent landslides, loss of forest reserves, soil degradation and droughts. The urgency to conserve and restore the watershed's ecosystem services to a stable state of land degradation neutrality is huge given the recurrent landslide devastation. To tackle this challenge, mobilizing the local population is key, from farmers to policy-makers, at all institutional levels. This requires a bottom-up participatory approach, in which generating intrinsic motivation, commitment and collaboration to invest in the watershed are crucial using the Participatory integrated planning approach. The project approach pursued a proactive and meaningful engagement of authorities and stakeholder groups from various sectors of the watershed, counting on the participation of public/governmental institutions, NGOs, and the private sector. By employing a watershed-based

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approach, the project was strategically designed to contribute to the actualization of some key sector policies.

Sustainable Development Goal 7; Clean and affordable Energy

As the population continues to grow, so will the demand for cheap energy, and an economy reliant on fossil fuels is creating drastic changes to our climate. Investing in solar, wind and thermal power, improving energy productivity, and ensuring energy for all is vital if we are to achieve SDG 7 by 2030. Expanding infrastructure and upgrading technology to provide clean and more efficient energy in all countries will encourage growth and help the environment.

Developing a community-based model for integrating bioenergy and poultry production using rice agro-waste: Prof John Kabasa

Objective: This project aimed at developing and deploying among rice-growing communities, novel technology innovations useful for integrated production of commercial bioenergy (Bio-energy combo) and poultry products using rice agro-waste. This was attained through a "One Health approach" to realize the optimal wellbeing for humans, animals and the environment.

Outputs: A series of sessions in an action learning fashion, experimentation trials and polishing of innovation products was carried out. For briquette making from agro-waste, modifications to suit rice agro-waste briquette processing were carried out. Both laboratory and field-based studies were undertaken to characterise the bio-briquettes. Low cost pyrolysis equipment was developed for carbonization of rice husk, its yield detailed at various operating conditions, and by-products extensively characterized and classified for purposive application. The project examined different combinations of substrates for producing cheap, safer and healthier prototypes of One Health rice agro-waste briquettes that have low levels of carcinogenic smoke particles, high calorific value and long burning time.

The briquettes developed will be used as an enabler for synchronized hatching and brooding of indigenous chicken, a process essential for efficient commercial indigenous poultry hatchery. This project established the knowledge of the technology and its applicability and produced a manual. This was conducted with the goal of deriving appropriate housing and husbandry conditions for indigenous chicken hatcheries suitable for small and medium scale rural poultry farmers.

Contribution to SDGs: 9,7,13, Integration of bioenergy into the existing household activities like poultry farming is a huge opportunity as some of the farmers who keep livestock, chicken in particular reported to do synchronized hatching which uses energy with this technology, this can be handy.

Sustainable Development Goal 8; Decent Work and Economic Growth

As the global economy continues to recover we are seeing slower growth, widening inequalities, and not enough jobs to keep up with a growing labour force. According to the International Labour Organization, more than 204 million people were unemployed in 2015. The SDGs promote sustained economic growth,

higher levels of productivity and technological innovation. With these targets in mind, the goal is to achieve full and productive employment, and decent work, for all women and men by 2030.

Pedagogical Leadership for Academic Staff in Higher Education Institutions to Enhance Graduate Work Readiness and Transition to Work; Prof. Ronald Bisaso

Universities across the globe are increasingly required to produce highly skilled graduates who are able to respond to the ever changing and complex needs of a dynamic labour market and workforce. There is a notable gap in linking graduate aspirations and employer expectations to the content and pedagogy in higher education institutions (HEIs) to enhance graduate work readiness and transition to work. Unfortunately, sixty- three per cent (63%) of Uganda graduates are unemployable according to the employers, and the existing pre labour market education or training is inadequate.

Objective; To build capacity for Higher education institution staff to implement university curricula using pedagogy that facilitates graduate work readiness and transition to work. However, they have disciplinary and research expertise.

Output; There is evolution of a National Innovation System where Higher Education Institutions (HEIs) work closely with National Council for Higher Education (NCHE), The National Planning Authority (NPA) and professional bodies among other stakeholders to integrate graduate work readiness and transition to work standards/guidelines into institutional policies and practices. Thus contributes to both SDG 8 and 9

Sustainable Development Goal 9; Industry, Innovation and Infrastructure

Investment in infrastructure and innovation are crucial drivers of economic growth and development. Technological progress is also key to finding lasting solutions to both economic and environmental challenges, such as providing new jobs and promoting energy efficiency. Promoting sustainable industries, and investing in scientific research and innovation, are all important ways to facilitate sustainable development. More than 4 billion people still do not have access to the Internet, and 90 percent are from the developing world. Bridging this digital divide is crucial to ensure equal access to information and knowledge, as well as foster innovation and entrepreneurship.

Crane Cloud: an open source multi-cloud service layer for highly available cloud-based services in Africa: Engineer Bainomugisha

Objective: To design and develop an open source multi-cloud service layer for highly available cloud-based services in Africa.

Output: Developed a Crane Cloud Prototype (MVP) and organised training to introduce University students to Cloud Computing from different perspectives.

Contribution to SDGs (4 and 9): Capacity building: Over 147 developers and students were trained on cloud computing and cloud-native application development. Additionally, 4 student developers and 3 interns were part of the development team for Crane Cloud. Additionally, the student developers

obtained hands-on skills in managing a local cloud infrastructure. The development of Crane Cloud demonstrated ability and possibilities for institutional clouds and cloud-native in resource constrained environments. Cloud-Native applications should be adopted if users are to benefit from application reliability in an environment with limited and failure susceptible infrastructure.

A Pedal-Operated Seed Cleaner (PoS-Cleaner) To Boost Post Harvest Grain & Legume Quality, Increase School-Study time & Create Financial Freedom in Rural-Uganda: Peter Tumutegyereize

Objectives: To develop a pedal-operated seed cleaner (PoS-Cleaner) to boost post-harvest grain & legume quality

Output: Five pedal operated seed cleaners were developed and distributed to five farmer groups which are active in grain crop production in Butansi and Namasagali sub counties in Kamuli District. The cleaner consists of a bicycle-like pedalling system, hopper, a centrifugal fan and three cleaning sieves which include two inside interlocking sieves and one fixed; whose meshes can be adjusted to be larger than the size of the unclean seeds by simply translating the second sieve to achieve the appropriate seed size. This allows trapping of foreign impurities larger than the seeds. Host farmers for the machines among the five groups were selected based on their potential to provide space and security for the machine as well as potential to train other farmers on the use and operation of the machine. For monitoring and evaluation of the use of the cleaners, a data collection sheet was also provided so that whoever uses the machine, registers his or her subcounty, parish, village, type of seed brought for cleaning, quantity cleaned, time taken, approximate distance from their homes to the host farmer and remarks for feedback. This provided important information for example, the effect of distance on machine use, the clean rate and user acceptance.

Contribution to SDGs (9): The five seed cleaning machines this project piloted proved necessary to the communities where they are located. At least 450 farmers have had access to these machines and used them since they were piloted.

Optimized and intelligent classroom environments for new generation learners: Fildah Ayaa

Objective: The main objective was to design an intelligent and optimized classroom model for university students

Output: An optimization software, "OPTISPACE' was designed to optimize classroom spaces. A social distancing feature was added during the COVID-19 pandemic and a user is able to determine the room capacity sufficiently. OPTISPACE can also be used to optimize space use in offices, warehouses, hospitals, and any other public spaces or places of business. A virtual reality feature in the software enables the

client to experience the space before it is built or re-modeled so that changes in the design are made before construction. A three-seater, two-seater and one-seater chairs comfortable for university students was designed and the prototype successfully tested. For room 160, a three-seater was recommended because of the large student number that has to fit in a limited space. It was estimated that 50 seats were required to fit the space from OPTISPACE and the chairs were fabricated in the CEDAT workshop. The chair features a central worktop, book case, bag hanger and leather covered seat for the comfort of the student following International design criteria.

Contribution to SGDs (9): Room 160 in CEDAT fully furnished with brand new furniture made in the University.

Sustainable Development Goal 10; Reduced Inequalities

Income inequality is on the rise and in developing countries, inequality has increased by 11 percent. Income inequality has increased nearly everywhere in recent decades, but at different speeds. It's lowest in Europe and highest in the Middle East. These widening disparities require sound policies to empower lower income earners, and promote economic inclusion of all regardless of sex, race or ethnicity. Income inequality requires global solutions. This involves improving the regulation and monitoring of financial markets and institutions, encouraging development assistance and foreign direct investment to regions where the need is greatest. Facilitating the safe migration and mobility of people is also key to bridging the widening divide.

Perspectives on Land Capping in Uganda (PLCU) Research Project: Zahara Nampewo

Objective: To elucidate on the challenges of unlimited private land ownership to development programming in Uganda. It interrogated whether it is possible to enforce a land ceiling and whether this would provide a solution to unregulated private land accumulation and under-utilization of land in Uganda.

Output: This study interrogated whether it is possible to enforce a land ceiling and whether this would provide a solution to unregulated private land accumulation and under-utilization of land in Uganda. It clarified the role of key players and actors regarding the aspect of land capping in Uganda but also capturing key voices – the voices of Ugandans on this critical issue. The recommendations of the research report are a resource for government, the private sector, and civil society to generate discussion and consent on this very sensitive and yet critical aspect of Uganda's development agenda. Relatedly, the study touched on other key factors central to land conflicts and with an effect on development;

• The land tenure system in Uganda – should it be reformed?

• How to improve land access for the poor and vulnerable – including women, youth and the new IDPs in Uganda (those who have lost their land due to land evictions);

• How to increase efficiency and transparency in land administration services and which institutions should be mandated for this.

• What is needed in developing / enhancing capacity in land administration.

Contribution to SGDs (10 and 16): The study established that there is considerable support for land capping which has the potential to facilitate the guaranteeing of a minimum amount of land for every person's livelihood including the poor and marginalised, while addressing current challenges of idle, unutilised land, speculative accumulation of land and the unregulated accumulation by the rich and powerful.

Sustainable Development Goal 11; Sustainable Cities and Communities

More than half of us live in cities at the moment. By 2050, two-thirds of all humanity—6.5 billion people—will be urban. Sustainable development cannot be achieved without significantly transforming the way we build and manage our urban spaces. The rapid growth of cities—a result of rising populations and increasing migration—has led to a boom in mega-cities, especially in the developing world, and slums are becoming a more significant feature of urban life. Making cities sustainable means creating career and business opportunities, safe and affordable housing, and building resilient societies and economies. It involves investment in public transport, creating green public spaces, and improving urban planning and management in participatory and inclusive ways as highlighted in selected Mak-RIF projects:

Improving the prediction of Storms and flood forecasting over Kampala City; Alex Nimusiima

Weather and climate issues have become increasingly recognised world challenges especially in the era of climate change. Kampala has faced a number of flooding events resulting from heavy storms in the past that have led to serious damages in many low-lying areas of the city. Theteam led by Dr. Alex Nimusiima from the College of Agriculture and Environmental Sciences aimed at addressing this challenge by improving the forecasting skills of such flood-causing magnitudes that affect the city through issuing early warning alerts and working with the relevant authorities. There was limited information on the influence of storm kinematics on the occurrence and generation of major floods in Kampala City. The team provided additional indicators that guide in the forecasting of heavy rainfall events that normally cause flooding in the city to the Uganda National Meteorological Authority (UNMA). This contributes to Goal 13 on Climate Action.

Sustainable Development Goal 12; Responsible Consumption and Production

Achieving economic growth and sustainable development requires that we urgently reduce our ecological footprint by changing the way we produce and consume goods and resources. Agriculture is the biggest

user of water worldwide, and irrigation now claims close to 70 percent of all freshwater for human use. Encouraging industries, businesses and consumers to recycle and reduce waste is equally important, as is supporting developing countries to move towards more sustainable patterns of consumption by 2030. This can help with food security, and shift us towards a more resource efficient economy:

Developing Monitoring System for Quantifying and Mapping antibacterials used in Livestock Farming Systems in Uganda: Lawrence Mugisha

Objective: To develop an Information Technology (IT) System for reporting antimicrobial quantities imported, distributed and used in livestock production systems in Uganda to inform surveillance and management of Antimicrobial Resistance (AMR)

Output: The project developed a web-based Information Technology System in collaboration with National Drug Authority (NDA) and Ministry of Agriculture, Animal Industry & Fisheries (MAAIF) that captures the importation data, sales data and purchase data of antimicrobial medicine in real-time and display it on IT dashboard in different usage formats accessible to regulators, policymakers, researchers, Veterinary drug importers and distributors and end-users (farmers). The system has in-built access levels for data protection and controlled access.

Contribution to SDGs (2,3,9,17): This Project was able to display antimicrobial data for animal use from import data to an IT dashboard visualised by regulators and policymakers in simplified formats. The data is extremely important to monitor antimicrobials imported and eventually used in different livestock. The data can be used to predict the antimicrobials being overused and likely to contribute to the development of resistance.

Harnessing microbial probiotics for improving pig health and productivity: Samuel Majalija

Objective: To unravel Lactic Acid bacillus strains with potential to improve pig health and productivity in Uganda

Output: The project isolated candidate probiotic organisms that have shown good results of promoting pig growth and reducing smell in piggery units. initial packaging of these organisms has been done and available to farmers.

Contribution to SDGs (1,2): The feeding costs of pigs will be reduced for farmers, A formulation of pig probiotics from indigenous organisms will be available on the Uganda market, There will be reduced use and reliance on antibiotics as a feed additive for pigs.

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GOVERNMENT OF UGANDA

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Agrochemical residues in meat and milk of cattle in the acaricide-tick-resistant infested areas: a case study of Gomba District: Peter Waiswa

Objective:To determine the level of agrochemical residues of Acelomectin and lava in meat and milk and the knowledge, attitudes, and practices that influence the application of agrochemicals on cattle in Gomba district.

Output: Socio-demographic and economic drivers for pesticide use in tick control were investigated by assessing knowledge, attitudes, and practices of farmers towards the use of pesticides to control ticks. In addition, beef samples (i.e. muscle tissue, liver and kidney) from butcheries and milk from selected farms were analysed for the presence and concentration of pesticide residues in the laboratory using HPLC.

Contribution to SDGs (3 and 2): This project has documented the use of agrochemicals to control ticks alongside conventional acaricides in Gomba district. Although the farmers know the effects of agrochemical residues on public health, they continue to use agrochemicals given the prevalent tick resistance. Policymakers should come up with measures to stop the use of agrochemicals on cattle to control ticks by giving farmers viable alternatives. There is evidence of contamination of meat and milk by agrochemical residues although to a small extent but this is likely to escalate if the use of agrochemicals against ticks continues unabated.

Profiling the role of Escherichia coli in the etiology of piglet diarrhea in selected pig producing districts of Central Uganda: Towards adoption or development of vaccines for prevention: Joseph Erume

Objective: To determine the role that E. coli plays in the etiology of piglet diarrhea in the smallholder pig farms in selected pig producing districts of Central Uganda.

Outputs: Fecal samples were collected from 2 piglets in each litter for E. coli isolation. Antimicrobial susceptibility testing of isolates was performed against WHO recommended antibiotics using standard protocols as described by the Clinical and Laboratory Standards Institute.

Contribution to SDGs (2): This study has revealed a high prevalence of enterotoxin gene markers among E. coli tested in piglets and highlights the potential role of these diarrheagenic bacteria in the etiology of piglet mortalities in Uganda. Additionally, this study has identified risk factors that can be observed to control infection and relevant drugs that can be used for treatment.

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Enhancing mango production and productivity for sustainable livelihoods in Uganda: Grace Nakabonge

Objective: 1. To assess the performance and production practices of mango varieties in selected districts of Uganda. To Investigate the level of pest and disease prevalence in mangoes orchards and the corresponding management practices in selected districts of Uganda and evaluate the influence of soil nutrient availability on mango fruiting in selected districts of Uganda

Outputs: Plots were established in farmer fields and susceptibility of different varieties to pests and diseases was evaluated. Finally, soil profiles at visited mango farms were characterized focusing on Nitrogen, Phosphorous, Potassium, Organic matter and soil acidity (PH) levels. Interviews were administered in farmers' mango orchards in order to crosscheck farmers' responses regarding the pest and disease status with field observations.

Contribution to SDGs (12): The information generated will inform policy (NAADS, Operation wealth creation) in their initiative towards promoting Mango production and productivity.

Goal 13; Climate Action

There is no country that is not experiencing the drastic effects of climate change. Greenhouse gas emissions are more than 50 percent higher than in 1990. Global warming is causing long-lasting changes to our climate system, which threatens irreversible consequences if we do not act. The annual average economic losses from climate-related disasters are in the hundreds of billions of dollars:

Development and optimisation of a biodegradable packaging solution for liquid based cosmetics using response surface methodology: Ronald Kayiwa

Objective: To develop and evaluate the performance of liquid based cosmetic packaging material from lignocellulosic waste.

Output: Tested for suitability of selected lignocellulosic waste for cosmetic packaging, developed an aesthetically acceptable packaging from lignocellulosic agricultural waste and evaluated the performance of the developed material versus the prevalent plastic packaging. Documented the Process of manufacturing containers from agricultural waste pulp without moulding

Contribution to SDGs: Use of agricultural waste has potential to improve livelihoods of farmers once a value chain for biodegradable cosmetic packaging is established (SGD 1,9). A better perspective environment with less plastic cosmetic packaging (SGD 13)

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Up-cycling plastic wastes by incorporation of agricultural residues for the development of environmentally friendly packaging products: Michael Lubwama

Objective: To develop up-cycled plastic packaging products using agricultural residues as filler materials

Output: Agricultural residues were used as reinforcing material in the production of egg-trays from plastic wastes in Uganda. Physical and thermal properties of both plastic wastes and agricultural residues were obtained by proximate analysis, ultimate analysis and TGA. Van Soest method was used to determine lignin, cellulose and hemicellulose compositions. Moisture absorption testing was carried out to obtain the rate of increase in weight when raw materials are soaked in water. These properties had an impact on the resulting up-cycled plastic packaging materials and products developed. Agricultural residues were dried to a moisture content of less than 1% using standard laboratory ovens.

Contribution to SGDs (9,13,1): The project creates a means of utilizing plastic wastes and agricultural residues to produce novel up-cycled plastic packaging products. This impacts on waste management including collection, sorting, re-use, recycling and up-cycling so as to achieve a circular plastics economy that is environmentally sustainable. This project built the capacity of local farmers on how they can use the wastes from their produce to develop upcycled products so as to reap extra income from agriculture. Jobs can be created in aspects of collecting agricultural residues and plastic wastes.

Sustainable Development Goal 14; Life Below Water

The world's oceans – their temperature, chemistry, currents and life – drive global systems that make the Earth habitable for humankind. How we manage this vital resource is essential for humanity as a whole, and to counterbalance the effects of climate change. Over three billion people depend on marine and coastal biodiversity for their livelihoods. However, today we are seeing 30 percent of the world's fish stocks overexploited, reaching below the level at which they can produce sustainable yields:

Strengthening the capacity of small holder fish farmers and fisheries extension officers to mitigate the risk of fish diseases in fish farms in Uganda: Samuel Posian Wamala

Objective: To improve fish health care in Uganda by increasing the knowledge of fish farmers and extension staff in detection, prevention and control of fish diseases

Output: An illustrated farmers' manual of fish diseases was developed. This is useful to fish farmers, fish health care workers/veterinarians, students and institutions concerned with fish health care. The manual demonstrates that fish diseases are actually a challenge in fish production in the country. Fish farmers and fisheries officers increased their awareness about fish diseases through the field training.

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Contribution to SDGs (14 and12): The project increased the knowledge of fish farmers and fisheries extension officers from Mukono, Mpigi, Buikwe and Wakiso through field training. This is expected to improve fish diseases detection, prevention and control and thereby improving fish production

Sustainable Development Goal 15; Life on Land

Human life depends on the earth as much as the ocean for our sustenance and livelihoods. Plant life provides 80 percent of the human diet, and we rely on agriculture as an important economic resource. Wildlife trafficking not only erodes biodiversity, but creates insecurity, fuels conflict, and feeds corruption. Urgent action must be taken to reduce the loss of natural habitats and biodiversity which are part of our common heritage and support global food and water security, climate change mitigation and adaptation, and peace and security:

Product formulation and evaluation of a herbal acaricide containing bioactive extracts of Albizia coriaria on acaricide resistant Rhipicephalus ticks: Bush Herbert Aguma

Objective: Product formulation and evaluation of herbal acaricide containing bioactive extracts of Albizia coriaria on larvae of acaricide resistant Rhipicephalus ticks.

Output: Herbal extract and herbal product were formulated using the stem bark powder of Albizia coriaria. Ticks larvae from 3 farms where resistance has been reported in Kiruhura District were exposed to the duplicates of the serial dilutions of 200mg/ml;100mg/ml/50mg/ml and 25mg/ml for both the extract and the herbal product using Larval Packet Test method. Tween 80 and Amitraz were used as the negative and positive controls respectively. The mortality was then determined after 24 hours and the average mortality for the duplicates per concentration was recorded. The results indicate that both the ethanolic extract and herbal acaricide of Albizia coriaria have slightly a higher mortality effect against the tick larvae compared to Amitraz. Therefore, the herbal acaricide formulated can be produced on a large scale and be used as a substitute to the failing synthetic acaricide in addressing the tick challenge in Uganda.

Contribution to SGDs (12,15): The findings show that a herbal acaricide can be produced on large scale to provide an alternative to synthetic acaricides

Sustainable Development Goal 17; Partnerships for the Goals

The SDGs can only be realized with strong global partnerships and cooperation. The world is more interconnected than ever. Improving access to technology and knowledge is an important way to share ideas and foster innovation. Coordinating policies to help developing countries manage their debt, as well as promoting investment for the least developed, is vital for sustainable growth and development. The goals aim to enhance North-South and South-South cooperation by supporting national plans to achieve all the targets. Promoting international trade, and helping developing countries increase their exports is

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all part of achieving a universal rules-based and equitable trading system that is fair and open and benefits all.

ICT Innovations Marketplace (InnoMak): Completing the Innovation-App-Adoption-Commercialization cycle: Dr. Mary Nsabagwa

Objective: To develop an innovation marketplace, which would help to promote Makerere University ICT projects, to ensure that they gain commercial value

Output: Developed a web-based innovations marketplace with a payment service to enable innovations teams to raise funds for use in developing more usable and advanced features. The innovations have social media pages on Facebook and Twitter accounts that will be used in promoting, marketing and branding the innovations to worldwide audiences. The portal is directly accessible to Makerere University and accounts can be created for other public and private universities for their innovators to use. The marketplace provides

Contribution to SDG17: The innovative marketplace provides an aggregated portal through which the promising innovations conceptualized and proof-of-concepts developed as early-stage prototypes by students in CoCIS every year can be found by the public and thus makes it easier to reach their intended users in Uganda and beyond.

Mainstreaming Kiswahili in Uganda's National Agenda for Regional Integration and Sustainable Development: Caroline Asiimwe

Objective: It was intended to critically discuss the ways and means of mainstreaming Kiswahili in Uganda's national agenda as an approach for promoting the development and use of the language. It aimed at demonstrating the efficacy of Kiswahili in strategically positioning the country for active participation in regional integration and sustainable development.

Output: The study adopted a multi-layered process of critical and contextual interpretation of the Kiswahili Language Question in Uganda from the colonial era to the present times, pointing out landmark decisions and actions that impacted the language in the country, as well as trends in policy fields in response to emerging development and integration imperatives. The study provided a comprehensive assessment of data collected from field participants using robust methodology, and synthesizes key findings and implications of main policy lessons.

Taking use and development domains as key analytic categories, the study deployed approaches that account for historical and contemporary shifts in the Kiswahili Language Question in Uganda. It gathered a set of data from participants for systematic and sustained analysis of mainstreaming Kiswahili in Uganda's national agenda. In pursuit of the relationship between Kiswahili and development and regional

integration, attention was paid to mainstreaming as a conceptual term and national agenda as a critical issue.

Contribution to SDGs (17): Appreciation of Kiswahili as a second official language, Sustainable partnerships and networking relationship among the line ministries and other stakeholders involved in the development of Kiswahili. Mind set change out of the sensitization and creation of awareness activities.

Conclusion

Makerere University continues to take the lead in driving research and innovations that foster development and provides solutions to day to day challenges in the community and the Nation. Through teaching, research and innovation

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