

## RESEARCH AND INNOVATION MANAGEMENT PROJECT

# SUPPORTING AFRICA'S SCIENCE GRANTING COUNCILS TO FUND AND MANAGE RESEARCH AND INNOVATION PROJECTS

## A Compendium of Project Abstracts

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**SUPPORTING AFRICA'S SCIENCE  
GRANTING COUNCILS TO FUND AND  
MANAGE RESEARCH AND INNOVATION  
PROJECTS (2023-2025)**

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**From Research to Impact: Driving Africa's  
Sustainability through Research-Policy-Innovation  
Synergies**

**SECOND ANNUAL SYMPOSIUM**

**AZALAÏ HÔTEL ABIDJAN,  
CÔTE D'IVOIRE**

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## FOREWORD

It is with great pride that I present this book of abstracts for the Second Annual Research and Innovation Management (RIM) Project Symposium. This publication captures the essence of a journey that began with a shared vision: to strengthen the capacity of Africa's Science Granting Councils in managing and funding research and innovation. Over the years, this vision has grown into tangible outcomes including but not limited to innovative solutions, strengthened collaborations and meaningful contributions to knowledge and development across the continent.

As the RIM project comes to a close, we can reflect on what has been achieved. From refining research frameworks to fostering inclusivity and advancing evidence-based decision-making, the progress made has been remarkable.

This symposium is also taking place at a pivotal time as the implementation of the Science, Technology and Innovation Strategy for Africa (STISA-2034) gains momentum. The outcomes of this project, and the insights shared here, align strongly with the strategy's vision of leveraging science and innovation to transform Africa's economies and societies. The work presented in these pages demonstrates that research, when well-managed and effectively connected to policy and innovation ecosystems, can deliver solutions that matter.

Additionally, the Symposium provides a platform to celebrate our achievements, share lessons learned, and explore pathways for sustaining impact beyond the life of this project. It is my hope that the ideas and innovations captured here will continue to strengthen partnerships and influence policies that drive sustainable development.

On behalf of the consortium, I express my sincere gratitude to all partners, researchers and stakeholders who have been part of this project from inception to completion.

**Executive Director, ACTS**

**Prof. Tom Ogada**

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# AGRICULTURE IN THE FACE OF CLIMATE CHANGE



# Stratégies durables de production et de conservation du maïs face au changement climatique à Tengrela en Côte d'Ivoire

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**Contexte:** En Côte d'Ivoire, le maïs constitue l'aliment de base pour les populations du nord, une matière première dans les industries et entre dans la formulation d'aliment pour les élevages. Cependant, les perturbations climatiques entravent la productivité ainsi que la conservation de cette céréale et la production est loin de satisfaire la demande nationale. Cette insuffisance est fortement liée à la faiblesse de la production mais également aux importantes pertes post-récolte enregistrées pendant la conservation. Ces pertes sont généralement dues aux attaques des nuisibles, principalement les insectes ravageurs dont les actions sont accentuées dans un contexte de changement climatique. Pour pallier ce déficit, les populations ont recours aux intrants chimiques de synthèse. Aussi, les structures de stockage et de conservation inadaptées rendent difficile la conservation et la disponibilité du maïs sur de longues périodes.

**Objectif:** Ce projet vise à contribuer à l'amélioration de la production et de la conservation des stocks de maïs par l'intégration des technologies d'agriculture intelligente.

**Méthodologie:** La stratégie est basée sur une approche participative avec les autorités coutumières, administratives et politiques, les médias, les producteurs, parmi lesquels les femmes et les points focaux. Les activités ont consisté à réaliser des enquêtes sociogéographiques basées sur la collecte de données qualitatives et quantitatives afin de caractériser le savoir et les pratiques endogènes des populations ainsi que les méthodes d'adaptation des producteurs. Des champs-écoles (parcelles expérimentales) et des structures améliorées de conservation du maïs ont été mis en place afin d'implémenter les technologies d'agriculture intelligente basées sur l'intégration des informations climatiques et l'utilisation de biofertilisants et biopesticides pour une meilleure production biologique. Ces activités sont menées avec les points focaux en vue de renforcer leurs capacités sur l'itinéraire technique du maïs dans le contexte du changement climatique.

**Résultats:** L'étude sociodémographique a permis de mettre en lumière la nécessité d'un appui technique et scientifique urgent intégrant les informations climatiques dans les pratiques agricoles afin d'optimiser l'itinéraire technique du maïs et développer des stratégies d'adaptation résilientes.

Les biointrants (biofertilisants et biopesticides) non toxiques pour l'homme, ni pour l'environnement ont montré leurs efficacités sur les sols et ont réduit l'action des ravageurs. Les structures améliorées ont permis de sécuriser la production et prolonger la durée de conservation du maïs pendant plus de 17 mois en réduisant les pertes post-récolte dues aux ravageurs, contrairement aux structures paysannes habituelles qui ne pouvaient assurer la conservation au-delà de 6 mois. Aussi, des sessions de formations/renforcements des capacités des bénéficiaires ont été régulièrement organisées pour une meilleure appropriation des résultats du projet. Plus, de 200 bénéficiaires ont été formés.

**Conclusion et implications:** La mise en œuvre de ce projet a mis en exergue les limites des pratiques paysannes sur l'itinéraire technique de production et de conservation du maïs dans le contexte du changement climatique. Les bénéficiaires formés seront des canaux de diffusion des innovations proposées dans ce projet. Ainsi, la production de maïs sera accrue et se conservera durablement pour satisfaire les besoins des populations et accroître les revenus.

**Mots clés:** Agriculture intelligente, Production et conservation de maïs; gestion post-récolte, structures de stockage, biointrants



# Phragmites australis, Smilax kraussiana and Tephrosia purpurea weed species are among the potential alternate hosts of coconut lethal yellowing phytoplasma in Mozambique

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Coconut production is a major source of income for most rural household and investors, however successions of Coconut Lethal Yellowing (CLY) disease outbreaks in Mozambique is compromising the income and livelihood of the affected people, and hamper current and future investors in the sector. Currently, disease management is based on early detection and immediate destruction of infected plants along with replanting using tolerant or resistant varieties. Knowledge of alternate hosts is crucial for effective integrated disease management. This study aims to search for potential coconut LY alternate hosts among herbaceous weed and cultivated species growing or cultivated within coconut farms. The study was conducted in Inhambane and Zambezia province, the CLY endemic regions. Putative alternate hosts were screened based on PCR. Phyto14 F and Phyto14 R, G183/ASKR and RhodeF/RhodeR primers pairs, designed to target LY phytoplasma from Mozambique, West Africa and Est Africa respectively were used. PCR analysis of Zambezia sample were finalized while samples from Inhambane province are still under molecular analysis. The PCR results using Phyto14F/R primers pair amplified eight (8) composite samples namely Phragmites australis, Pennisetum purpureum, Psidium guajava, Saccharum officinarum, Smilax kraussiana, Stenotaphrum secundatum, Tephrosia purpurea and Waltheria indica, from five 5 botanical families specifically Poaceae, Myrtaceae, Smilacaceae Fabaceae and Malvaceae families. Phragmites australis and Psidium guajava were also amplified with primer pair RhodeF/R designed to amplify Tanzanian Lethal Decline phytoplasma species, while, Phragmites australis, Smilax kraussiana and Tephrosia purpurea were co-amplified with primer pair G813/AKSR designed to amplify Candidatus Phytoplasma palmicola species. Pennisetum purpureum, saccharum officinarum, Stenotaphrum secundatum, Waltheria indica were only amplified by Phyto14F/R, while Phragmites australis were positive for the three primers, which highlight the likelihood of Phragmites australis being the actual CLY phytoplasma alternate hosts. Among the families reported as being the potential hosts in the present work, Poaceae stands out from the others for presenting a greater number of PCR positive, putative alternative hosts (4), which is equivalent to 50% (4/8) of the potential hosts identified in the present study. The PCR positive samples exhibited the greatest abundance, which suggests that its abundance in coconut production fields may increase the probability of being potential alternative hosts. The potential alternate hosts screened, were selectively detected by three different primers which is in line the previously reported high diversity of phytoplasma species associated with CLY in Mozambique. The results from this study should be confirmed by sequencing the PCR positive products. The updated knowledge of CLY alternate hosts will contribute to the more sustainable integrated disease management

**Key words:** Coconut Lethal Yellowing, alternate hosts, PCR

## Coconut lethal yellowing: Dynamics in coconut plantations and adaptation of Yaokro and Badadon populations, Grand-Lahou, Côte d'Ivoire

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Coconut Lethal Yellowing (LY) is a phytoplasma-induced disease that poses a significant threat to coconut production in Côte d'Ivoire (CI) and Mozambique (MZ). This disease has severely affected coconut farming in both regions, which is a source of income for many coastal communities. The ongoing spread of LY presents a major threat to their livelihoods, further exacerbating the challenges faced by these populations. The overarching objective of this study is to ensure the long-term viability of coconut cultivation in both Côte d'Ivoire and Mozambique. To achieve this, the study aims to develop an early warning system for LY in coconut trees. Specifically, the objectives are: (i) characterizing the evolution of LY in coconut plantations, (ii) identifying techniques for adaptation and resilience of populations. To do this, six disease surveillance sites were established in Côte d'Ivoire. Land-use data were collected through the combined use of GPS, and drone technology. A questionnaire-based survey was also conducted with several targeted groups to assess the local population's adaptation in relation with the disease. The results show that in the monitoring plots, the distribution and progression of the disease are a function of the stages, with a prevalence of 100%. The incidence and severity of the disease differed from plot to plot. The number of spots marking the progression of the disease decreased with an increase in surface area. 10 vegetation indices were selected and the ACI and NDRE indices better discriminate the disease according to its stage. 80% of the population believe that the solution to the disease lies in scientific research and the introduction of resistant coconut varieties. Cultivation practices, such as spreading fertiliser (32%) and felling trees (52%), also play a part in combating the disease. To reduce dependence on the coconut palm, crops such as manioc (72.22%), oil palm (8.33%), maize (5.55%), watermelon (11.11%), coffee and cocoa (2%), market gardening (0.5%) and rubber (0.5%) are proposed. This integrated approach provides a multidisciplinary strategy for managing Lethal Yellowing and should help revitalize the coconut sector. It offers solutions to combat the disease which continues to spread to new areas.

## Rwanda cricket farming project

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*Mr. Musabirema Alexis*

The Rwanda Cricket Farming Project, implemented by Nutrifarm Ltd, addresses the persistent challenge of high malnutrition rates among infants under five and pregnant women in Rwanda, which stands at about 33%. The project aims to develop and scale up the production of affordable, protein-rich food alternatives derived from edible crickets. By using innovative farming techniques and industrial processing, the project produces high-protein paste and powder that can substitute traditional animal proteins like beef and skimmed milk powder, offering a sustainable, healthy solution to protein insecurity. To achieve this, Nutrifarm Ltd is raising USD 2 Million to implement the 5 years' business plan and boost its production capacity through research scale, product development, staff training, purchase of specialized equipment, and improved processing systems that ensure food safety and meet both local and future international standards. The initiative committed to engage internees' local youth and women throughout the value chain, creating decent jobs, building technical skills, and strengthening small business opportunities linked to cricket farming and processing. Next to 18 month's journey, the project plans to reach at least 10,000 malnourished infants and pregnant women, backed by a trained team of 500 personnel working across Rwanda. This will be achieved through increased business capacity planned to reach 1 million pieces produced per month as per the 5 years Business plan 2025-2030. Findings from this project will not only contribute to national nutrition goals but also add evidence on how insect protein can support global climate resilience efforts by reducing pressure on livestock farming and cutting greenhouse gas emissions. The project's scalable model and integration of climate-smart practices position Nutrifarm Ltd as a Centre of Excellence and leading manufacturer in edible insect farming and processing in Rwanda and the region. This project demonstrates how locally driven innovation, inclusive community engagement, and sustainable agri-food solutions can tackle malnutrition, generate income, and promote climate action at once. For more information about the project, please visit the website: [www.nuttrifarm.rw](http://www.nuttrifarm.rw)



# Potential of indigenous vegetables to combat food insecurity and malnutrition in rural households in Sierra Leone

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**Introduction and significance:** indigenous vegetables (ivs) are locally adapted plants consumed as accompaniments to staple foods, typically harvested from the wild and completing their life cycle within a year. Ivs serve as vital sources of vitamins, minerals and proteins, particularly in rural diets. However, malnutrition persists in rural households due to insufficient vegetable consumption. This study evaluated the potential of indigenous vegetable species to combat food insecurity and malnutrition in rural sierra leone. Identifying nutrient-rich ivs could offer sustainable solution to malnutrition, promote dietary diversification and increase savings.

**Methodology:** using a multi-stage sampling techniques, 1,200 iv utilizers were selected across sierra leone. Data were collected through semi-structured questionnaires, focus group discussions, and field observations, and then analyzed using descriptive statistics.

**Results:** a total of 40 iv species from 12 families were documented across agro-ecological zones in sierra leone. The solanaceae family had the highest diversity (9 species), followed by cucurbitaceae (6 species), and amaranthaceae and piperaceae (3 species each). Notably, piper umbellatum, piper guineense, and solanum nigriflorum were restricted to rainforest and transitional rainforest zones, which are rich moisture and nutrient soils. Of the 40 species identified, 18 (45%) were actively used and 22 (55%) underutilized or neglected due to seasonal unavailability. Findings also revealed that elderly married women (69.5%) with no formal education (59.2%) were mostly involved in the indigenous vegetable sector. Most (88.2%) of the respondents (predominantly women) used ivs for food, income and therapy. The consumption of ivs (mainly by the elderly) was reported to have nutritional, medicinal, and cultural values. Another 11.3% (mostly youths) did not consume ivs, citing undesirable food characteristics (unpleasant taste, flavor, and preparation challenges) and sociocultural factors (e.g., “kamajor” and “donso” societal influences) for not consuming ivs. Limitation to dietary diversity is a contributing factor to malnutrition in rural communities in the country.

The key determinants of iv consumption frequency included demographic and socio-cultural factors such as availability, gender, age, education, household size, and tradition. The elderly consumed ivs more frequently than the young and the less or non-educated consumed them more frequently than the educated. While synonymous to poverty and lack of traditional preparation knowledge were cited as main reasons for non-consumption by the educated and young, health and nutritional benefits were cited for consumption by the elderly. These conflicting perceptions hinder efforts to improve rural nutrition.

**Conclusion and implications:** sierra leone has a diverse rich resource of ivs highly useful as food, medicine, and income. However, a significant portion (55%) iv species remains underutilized due to their seasonal traits. Socio-demographic and cultural characteristics were the determinants of household consumption frequency of ivs. Addressing socio-cultural barriers and enhancing availability of ivs through the establishment of clonal gardens, holding of public awareness campaigns on the benefits of ivs, and improvement of preparation techniques could boost consumption. Further research is required on developing improved ivs traits for food, pharmacological, and cosmetic uses.

**Keywords:** indigenous vegetables, rural household, socio-cultural value, malnutrition, food insecurity, sierra leone

# Genetic characterization of hybrids resulting from the cross between *Tilapia guineensis* (Günther, 1862) and *Tilapia zillii* (Gervais, 1848) in two sectors (IV and V) of the Ebrié lagoon

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*Tilapia*, also called *Coptodon*, are the predominant species in commercial fish farming in Africa and more particularly in Côte d'Ivoire. These fish species are also known for their ability to hybridize in natural environments as well as in captivity. The natural hybridization between *Tilapia guineensis* and *T. zillii* is an example of gene flow due to environmental disturbances. Although this hybridization is addressed in certain watercourses, the one that occurred in the Ébrié lagoon is very little documented. Studies on this hybridization have reported a predominance of hybrid tilapia at the expense of *T. guineensis*. However, there is a lack of knowledge about the extent and intensity of this hybridization. The present project aims to identify all aspects of this hybridization in sectors IV and V of the Ebrié lagoon. This study was conducted on male and female individuals of *T. zillii* and hybrid *T.* derived. A total of 320 individuals of *T.* hybrid (200 males and 120 females) and 255 individuals (150 males and 105 females) of *T. zillii* were taken into account for the morphometric study. The captured fish were digitized by the method of homologous points (landmarks) using the CLIC software. Nineteen (19) reference points were placed on each of the fish images digitized by a single operator using the XYOM program. Genetic analyses will rely on nuclear DNA and mitochondrial DNA through the examination of microsatellites and mitochondrial haplotypes. The physico-chemical parameters of the environment were measured over an entire year. The results of the study of physico-chemical parameters show that the water in sectors IV and V of the Ebrié lagoon is warm (average 29.79°C). Dissolved oxygen levels were relatively low (average 8.07 mg/l) at all stations throughout the study period. Conductivity and dissolved solids levels were high, with low water transparency. With regard to the morphometric study, the average variation in centroid size at the intraspecific level showed that there is sexual dimorphism in *T. hybrid* and *T. zillii*. Males are on average larger than females. The interspecific study shows that hybrids differ from the *T. zillii* parents in size and shape. Indeed, the centroid sizes of the males ( $10.19 \pm 1.36$ ) and females ( $9.35 \pm 1.37$ ) of the hybrids are respectively larger than those of the *T. zillii* males ( $8.38 \pm 1.13$ ) and females ( $7.86 \pm 0.98$ ). This could be explained by the heterosis effect (the hybrid is more vigorous than the parents). The data collected show that *T. guineensis* is indeed an endangered species. Only 20 individuals were collected during 12 months of sampling, which makes it impossible to carry out a morphometric study of this species. In addition, the hybrids are larger than the *T. zillii* parents. The heterosis effect could partly explain the scarcity of *T. guineensis* parents in sectors IV and V of the Ebrié lagoon. Molecular analysis currently underway could provide more information on the contribution of each parental line in the genome of hybrid individuals through the admixture rate.

**Keywords:** Tilapia, hybridization, morphometry, DNA, Physico-chemical parameters

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## RESEARCH AND INNOVATION: GENDER AND INCLUSION





## Women's participation in STI research, capacity building and mentorship programmes: The trends, barriers and enablers (WESTIR)

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**Background and Significance:** Science, Technology, and Innovation (STI) are foundational to socio-economic development. However, gender disparities in STI remain significant worldwide, with women comprising less than 30% of global researchers. In Africa, despite growing recognition of the importance of inclusive scientific development, women remain underrepresented in STI research and leadership. Existing interventions have largely focused on increasing girls' participation in STEM education, with limited attention to systemic barriers affecting women's recruitment, retention, and progression in STI careers. This imbalance leaves critical gaps in addressing Africa's gender equity agenda. Although some interventions, particularly capacity building and mentorship, have been promising in bridging the gap, a deeper understanding of both challenges and facilitators is required. This study aimed to identify key barriers and enablers to women's participation in STI research and to offer evidence-informed recommendations.

**Methodology:** A mixed-methods design, combining semi-structured interviews with group discussions was employed to capture diverse experiences across female and male staff in two public research institutions, a regulatory agency and a private sector organization. The institutions are Council for Scientific and Industrial Research (CSIR), Ghana Atomic Energy Commission (GAEC), Environmental Protection Authority (EPA) and Bonstech Sustainability and Management Experts (Bonstech). Thematic content analysis was conducted on qualitative data while the quantitative data was subjected to descriptive statistics and regression analysis.

**Findings:** The current female scientists' population in the institutions are CSIR (34.9%), GAEC (33.0%), EPA (29.5%) and Bonstech (50.0%) with variations across institutes and departments. Overall, only 30-40% of respondents were satisfied with their current job, and the major barriers related to working conditions included poor working facilities, unsatisfactory promotion process, low remuneration and constrained work-life balance especially for females. The most reported forms of gender-based violence were discrimination and intimidation, including bullying by superiors, inappropriate comments and accusations, and exclusion and sidelining. Lack of mentorship is another barrier as 69% of respondents had never participated in mentorship/fellowship programmes. Other areas of concern to women were lack of institutional support, health and safety risks, male-dominated environment and gender stereotypes, and discouragement from social network including family and friends. The main enablers reported were job stability and flexibility, collaboration with colleagues, and opportunities for capacity development; with 25% of respondents currently on study leave. Enablers such as targeted capacity-building programs, institutional support mechanisms, and active mentorship networks were found to facilitate women's career progression. Additional enablers included encouragement and emotional support from social networks such as workplace colleagues, spouses, and children. Potential enablers were alignment between the job and one's program of study and career goals, a gender-sensitive work environment, access to more funded projects, and better incentives.

**Conclusion and Implications:** Female participation in STI research is still low compared to males. Eliminating the barriers whilst sustaining and improving the enablers could encourage more female participation and retention in STI research and regulatory work. The findings underscore the need for comprehensive, evidence-based policy reforms to promote gender equity in STI and harness the full potential of the scientific workforce for socio-economic development.

**Keywords:** Women, STI Research, Capacity building, Mentorship, Barriers, Enablers

## Appui à l'autonomisation économique des femmes riveraines du parc national d'Azagny par l'introduction de la production locale de *Cardisoma armatum* (crabe poilu) dans leurs habitudes agricoles

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**Contexte et signification:** La population ivoirienne active est constituée de 36,8% de jeunes dont 5,3% sont au chômage. Le manque d'activités affecte leur pouvoir d'achat. Cette situation est encore plus accrue au niveau des populations riveraines des aires protégées, les poussant ainsi à faire des incursions illégales dans celles-ci. Le Parc National d'Azagny ne déroge pas à la règle. En effet, il est assailli par les populations riveraines, principalement par les femmes, à la recherche de crabes poilus (*Cardisoma armatum*), une denrée très prisée dans cette localité. Elles exercent par ces pratiques une pression sur ledit parc. Pour remédier à cette situation, le présent projet, qui a pour objectif de contribuer à l'autonomisation des femmes de Braffedon, village riverain du Parc National d'Azagny, par la domestication du crabe poilu est mis en œuvre.

**Méthodologie :** Une enquête socioéconomique de la population cible (village de Braffedon) a été faite. Une formation des femmes de la coopérative locale « WACHIAWO » participant au projet a été effectuée. Des noyaux de crabes poilus ont été mis à la disposition des femmes formées. Des analyses biologiques permettant respectivement de connaître les charges microbiennes de ces crabes et de déterminer leurs compositions nutritionnelles sont en cours.

**Principaux résultats:** L'enquête socioéconomique réalisée sur 150 ménages, a montré l'intérêt des populations de Braffedon (97%) pour ce projet. Une population de crabes poilus (100 crabes) a été introduite dans le hangar d'élevage, après que les femmes de la coopérative (20 femmes) aient eu une formation. Les résultats des analyses en bactériologie ont montré que les crabes poilus sont contaminés par les Coliformes fécaux, *Bacillus* spp, *Streptococcus* spp, *Vibrio*, *Klebsiella*, *E. Coli* et par *Staphylococcus aureus*. Les souches de *Salmonella* n'ont pas été retrouvées dans aucun des échantillons de crabes. Les analyses nutritionnelles ont quant à elles montrées que les crabes contenaient entre autres 19,8 % de protéines, 5,1 % de lipides, 0,2 % de glucides, 22,9 mg de vitamine B9 et respectivement 304 mg et 276 mg de sodium et de phosphore.

**Conclusions et implications :** Cette nouvelle pratique d'élevage vient renforcer les capacités économiques et le pouvoir d'achat des femmes de la coopérative de Braffedon par la production et la commercialisation de crabes poilus. Elle permettra d'accroître leur autonomie financière et d'assurer la sécurité alimentaire des ménages. Ce projet contribue aussi à la préservation de la biodiversité du Parc National d'Azagny.

**Mots clés:** *Cardisoma armatum*, domestication, autonomisation, préservation, parc

## Capacity building for job creation and growth of leather goods and footwear manufacturing enterprises in Kenya

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Leather sector has a potential to create the much-needed jobs in Kenya. The sector aspires to create a competitive integrated value chain to drive the leather and leather products manufacturing industry. The leather goods and articles sub-sector is largely driven by the huge informal sector that has continued to thrive. However, the sector's projected growth is yet to be realised. Gaps still exist in terms of training and knowledge sharing. Kenya's manufacturing agenda in the leather and footwear sector has prioritized the leather and footwear sector as a driver for the country's industrialization. The Kenyan government has indicated that in the near future, they will be stopping the importation of shoes, but if this is implemented in the current state of affairs, as a country, will not have the capacity to meet the demand. Studying the Kenyan leather value chain is key in identifying the existing gaps and finding solutions that allow the country realize its full potential. Training Institutions in Kenya have mounted courses in leather training to try and fill the existing skills gap. However, the mounted programmes failed to attract critical numbers for training. Some institutions ended up discontinuing the programmes, and those that are still running have few students enrolled. Attempts to enroll those who joined the sector without formal training in the field of leather in order for them to upgrade their skills have equally proven futile. They shun the 3- or 4-year training programmes and indicate that they would prefer short courses that last for a few days. The project aimed at creating an opportunity for the youth, women and persons living with disability (PLWDs). The trainees were drawn from Nyeri, Nyandarua, Isiolo, Kisumu and Nakuru counties in Kenya to access knowledge and gain skills that will enable them venture into production of finished leather goods and footwear, or acquire new and specialized skills necessary for the growth of their ventures. The trainees were taken through three phases; I (theoretical training), II (leather goods manufacture), and III (footwear manufacture). At the end of the training, the trainees were found to possess excellent competencies in leather manufacture and can be recruited as trainers of trainers (TOTs) for possible deployment to train more players in other counties. With these initiatives, more MSMEs will produce more products for the local market to support the Government's local manufacturing development agenda on "Buy Kenya Build Kenya" strategy. Undoubtedly, government's Vision 2030 will be realized and more jobs created with trainees improving their income.

# Impact of agribusiness incubation/innovation hubs on youth agripreneurship development: Lessons for Ghana's agro-food industrial transformation

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**Background and Significance:** Innovation hubs have emerged as critical enablers of small and medium-sized enterprise (SME) growth, fostering innovation and collaboration in an increasingly competitive and digitalised global economy. However, these hubs face significant challenges that affect their survival and resilience. The mechanisms through which they contribute to SME value creation in the agri-food sector remain insufficiently understood. This study empirically assesses the impact of agri-innovation hubs in Ghana, examines the challenges they face, and draws lessons for transforming the agro-food industrial sector.

**Methodology:** The study relied on cross-sectional data collected through a survey of 208 beneficiaries randomly selected from twelve agri-innovation hubs across five regions of Ghana. A mixed-methods approach was adopted, with qualitative data gathered through focus group discussions with hub managers and administrators. Quantitative analysis was conducted using a logit model.

**Results/Key Findings:** The findings highlight the multifaceted contributions of innovation hubs in developing new products, enhancing business performance, and sustaining their own operations. Business management and technical agripreneurial skills are key areas of impact created by these hubs. Skills developed by beneficiaries through their engagement include business management, financial literacy, sales and marketing, and communication skills. A majority of beneficiaries (54.4%) had been associated with the hubs for less than a year, with agro-processing being the main value chain activity undertaken by most (47.6%) of them. The most valuable support identified by beneficiaries is the training received from the hubs. Quantitative analysis revealed that household membership in an innovation hub, age, access to extension services, and the development of new products significantly influence the value-creation activities of agri-innovation hubs in Ghana. However, key challenges in youth agripreneurship development include limited access to finance, a complex regulatory environment, cumbersome legal and administrative processes, and limited expertise in the agribusiness food sector. Inadequate mentorship and support networks also remain primary obstacles for young agripreneurs in delivering innovative solutions within the agro-food sector.

**Conclusion and Implications:** Agri-innovation hubs (AIHs) have the potential to catalyse the growth of SMEs in the agri-food sector. The development of new products by these hubs is directly linked to value-creation activities within SMEs and the broader agri-food sector, underscoring the need to support start-ups in this area. Fostering sustainable and inclusive innovations can have a long-term impact on youth agripreneurship, and integrating ICT tools into the agri-food sector is essential for creating jobs for young people. This study provides actionable insights for policymakers, hub managers, and entrepreneurs seeking to maximise the impact of innovation hubs on their target beneficiaries. More support is needed for value chain actors engaged in processing. Continuous training, coaching, mentoring, and follow-up support are vital for sustaining the gains made by innovation hubs. Greater political will is also required from government to reduce the constraints faced by SMEs and AIHs and to create an enabling business environment.

**Keywords:** Agripreneurship development, Innovation hubs, Value creation, Impact, Ghana

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## Smart Poultry Farming (SPF): AI-driven, off-grid innovation for sustainable protein production in Zimbabwe

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**Background and Significance:** Zimbabwe's poultry sector faces constraints from inefficient production systems, high mortality rates, and limited access to precision farming tools. The Smart Poultry Farming (SPF) project tackles these challenges by developing an AI-enabled, IoT-integrated poultry management system to enhance productivity, biosecurity, and environmental sustainability. The system optimizes feed efficiency and monitors health parameters in real time, reducing losses and improving yields. It also promotes data-driven decision-making for farmers, aligning with modern agricultural advancements. The project supports national rural industrialization goals and the Education 5.0 philosophy, targeting both indigenous and commercial poultry systems.

**Methodology:** The project employs a modular, participatory design approach across two pilot sites. Key components include:

- Construction of insulated poultry housing (15m x 30m)
- Deployment of AI-enabled sensors, cameras, and edge-computing IoT systems
- Automated feeding, watering, and climate control systems
- Integration of a 10kW solar PV backup system
- Real-time monitoring dashboard with predictive analytics
- Cross-training workshops and stakeholder co-creation sessions

Data is collected via sensors and computer vision, analyzed using machine learning models (e.g., neural networks, decision trees), and used to trigger automated responses or alerts.

### Key Findings / Preliminary Results:

- 85% of infrastructure setup completed; solar and smart modules procured
- AI architecture developed for health monitoring, feed optimization, and climate control
- Early simulations show potential for 60% reduction in energy costs and improved flock health outcomes.
- Strong community engagement and interest in agritech entrepreneurship
- Partnerships initiated with private poultry firms and regional research institutions

**Conclusion and Implications:** The Smart Poultry Farming (SPF) project provides a scalable model for digitally enabled, off-grid poultry farming in Africa. It showcases the integration of AI, IoT, and renewable energy to drive rural industrialization, youth empowerment, and sustainable protein production. By leveraging advanced technologies, the project enhances operational efficiency and supports resilient farming practices. It also fosters inclusive growth by equipping young farmers with digital tools and skills. Additionally, the project contributes to policy dialogue on smart agriculture and strengthens innovation ecosystems.

**Keywords:** Smart Agriculture, Poultry Innovation, Artificial Intelligence, Renewable Energy, Rural Industrialization



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## VALUE ADDITION OF AGRICULTURAL VALUE CHAINS





## Maize germ and bran as raw materials for high fiber value added bakery and confectionery products

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Maize is the most important cereal food crops with 86% of the 4.2 million agricultural households are engaged in its Uganda. Processing of maize results into large amounts of bran and germ as byproducts that widely used in animal feed production. Maize bran is a rich source of minerals and additional fiber for different value added products hence important in the promotion of good health. Maize germ is high in essential oils, vitamins and proteins. The consumption of refined flour-based products contributes to the increase intake of refined carbohydrates translating into increased Non-communicable diseases (NCDs), such as cardiovascular diseases and type 2 diabetes, which are a growing health burden in Uganda, contributing to 36% of total deaths.

In the view of increasing awareness and demand for healthy foods, this project incorporated maize bran and germ to developed high fibre baked products with health benefits. In the product formulation, maize bran (0-60%) and maize germ (0-30%) was used. The developed products were baked at 205°C for 15-30 minutes. The products developed included cakes, cookies, crackers, bread, buns, bran sticks and muffins. The different products were subjected to chemical analysis and sensory evaluation. Market surveys were conducted involving 200 consumers. Sensory analysis revealed that incorporation of maize bran at 40% while germ at 20% resulted cakes and cookies with good eating qualities. Higher levels of maize bran and maize germ than above negatively affected texture, taste, and overall acceptability. Proximate analysis revealed the developed products had increased dietary fiber, ash, and total phenolic content, with reduce carbohydrate content compared to control cookies. The fiber content of developed products ranged from 0.34% to 6.36%. Out of about 200 customers, 90% indicated that the products were acceptable and ready to repeatedly purchase the products.

These findings suggest that maize bran and germ can be effectively used to produce acceptable baked products with enhanced the nutritional attributes supporting dietary strategies to prevent NCDs. Addition of maize bran to baked products has revealed the possibility of reducing the amounts of sugar used in these products. This finding has a great significance for health as many consumers are striving to reduce their sugar intake.

**Keywords:** Maize, Maize bran, Maize germ, bakery products, NCDs

## Scaling up of post-harvest loss reduction technologies for horticultural crops using biomass waste packaging

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The development of postharvest technology for horticulture crops is inevitable to mitigate the huge loss in the area. In Ethiopia, food wastage is exponentially growing and the annual loss worth approximately 282-Billion-ETB. This project is aimed at scaling up of postharvest technology for tomato, avocado and mango fruits packaging from tomato biomass fiber. So far, we have conducted a consultative meeting prior to the execution of the experimental trials and industrial scale optimization and production to meet the inception of Objective one (1). Huge amount of tomato stalk biowaste has been collected by the farmers at Wonga and Adam area and has been transported to Barua Trading PLC for the first batch optimization and commercial scale paper production and testing has been done. A total of three (3) female research fellows were recruited from Adama Science and Technology University (ASTU) and involved in the experimental work of this project. Two female fellows have been engaged in extraction and modification of Cassava and Avocado seed starches, respectively. The modified starch products were successfully tested at Ethio-Pulp and Paper S C for its suitability as internal sizing agent. The synthesized and optimized avocado seed and cassava starch binder has demonstrated a remarkable degree of oxidation (DO) valued 51.3% and 56.1%, respectively. Additionally, the modified starches have shown higher gelation temperature as compared to that of the native starch from the two starch sources thereby enhanced the quality of the packaging paper. In the first batch industrial scale pulp and paper optimization and production stage, we have fruitfully produced the pulp material with high freeness, self-binding nature. Our investigation on additional inputs that can enhance the water barrier properties of the technology has indicated a remarkable results/led to new findings and collaborations. Finally, we have successfully produced a rim of paper that suits for development of fruit packaging material. Important lesson has been learnt from the kickoff workshop, student training events, MEL workshops and industrial process optimization. As part of our knowledge dissemination plan, we have received two patents from Ethiopian Intellectual Property Authority (EIPA) and released news on the social media platforms (telegram and Facebook) of BETin and public main stream medias (Fauna Media Corporation and Ethiopian News Agency). Overall, this project had brought farmers, female students, private industries, researchers together from the supply chain of the biomass to the industrial process optimization. Therefore, throughout the value chain there is an indication to create jobs and contribute to the economic development and regional integration. With a slight process modification, it is not far to push the product into the market. In collaboration with a private company, Barua Trading PLC, and Ethio Pulp and Paper S C we are planning to commercialize the products with a little modification on the production unit.

**Key words:** Postharvest technology, Female researchers, Students training, Starch modification, Biomass waste, Industrial process, Rim paper product, Commercialization

## Agricultural recovery of biowaste to support the achievement of food sovereignty

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Senegal produces more than 2.7 million tons of solid waste per year, about a third of which is organic waste. In Dakar, this represents nearly 2,613 tons per day. Faced with the degradation of agricultural soils and growing dependence on chemical fertilizers, the recovery of this organic waste offers a sustainable alternative to strengthen food security, limit environmental impacts, and promote eco-responsible agriculture. Compost, digestate, and biochar are natural fertilizers derived from local resources, addressing climate and energy challenges. The project aims to establish a biowaste treatment platform at ISRA-Sangalkam. Activities include: (i) composting of organic waste; (ii) methanization of biodegradable substrates; (iii) biochar production from Typha. The project includes the supervision of Master II students and inter-institutional collaboration for product analysis and agronomic evaluation. The composting station was set up, equipped, and made operational. Biochar was produced at two sites (ISRA-Bel Air and UASZ). Methanization tests were launched, with successful biogas production. Two Master II theses were developed: one on optimizing composting, the other on activating methanization using biochar inoculum. A mini-orchard has been installed for future experiments. Biochar, in particular, is generating strong interest as a biological activator and soil conditioner. Preliminary results confirm the technical feasibility of integrated biowaste recovery. The next steps of the project will include field agronomic trials, the writing of scientific articles, the dissemination of practices among producers, and support for large-scale compost production projects from organic waste. This project represents a strategic step towards sustainable organic waste management, a circular economy, and resilient and inclusive agriculture in Senegal.

**Keywords:** Biowaste, composting, methanization, biochar, sustainable agriculture

## Reducing postharvest losses and increasing farmers' income through quality improved dried tomato products in eastern Tanzania

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**Project Background and Significance:** Globally, about one-third of food produced is wasted (FAO, 2019) and indication of failed food system (UNFSS, 2021). Post-harvest losses pose a serious threat to food security in Tanzania. and mitigation can offer largest opportunity to alleviate hunger and nutrition problems. Tomatoes contribute to a healthy, well-balanced diet however are highly perishability leading to loss up to 50% (URT, 2019). The proposed project seeks to increase efficient of drying tomato, evaluate appropriate packaging material for tomato powder storage and hence increase shelf-life of tomato. Use of improved solar drying technologies has proved to extend shelf life and increase income to farmers. The project seeks to reduce tomato postharvest losses through use of efficient drying and storage technologies. **Specific objectives**

- i. To adopt and perfect energy efficient convectional drier for drying tomato
- ii. To establish shelf life of dried tomato powder
- iii. To determine the profitability of dried tomato products
- iv. To assess acceptability tomato powder and disseminate use of developed technologies

**Methodology:** The research is conducted in Morogoro and Coastal regions, reported as among leading tomato producing areas. Tomato samples used for the shelf-life study were collected at an unripe stage from selected farmers. Multistage sampling for selecting food vendors, food establishments and marketplaces for profitability study.

**Preliminary Results:** A hybrid solar dryer, integrating both a photovoltaic (PV) system and alternating current (AC) was adopted and perfected. The drier current capacity is 100kg for 13 hours to attain moisture content between 10- 11%. Experiment for establishment of shelf life for tomato powder is underway. Data for four months has been collected, and analysis is still ongoing; preliminary analysis has shown is stable under in the used packages (PET laminated bag; aluminum laminated bags (PE/Al/PET) and polypropylene container). The acceptability of dried tomato powder and processed products was assessed. Sensory analysis for plain tomato powder and two tomato powder recipes for sauce making was done. General acceptability of dried tomato products was high. Data collection tools for assessing profitability were developed and pre-tested. Preparation for the survey which will be one in August is underway. A total of 18 small scale processors at Kilosa districts were trained in tomato processing. The training comprised of good manufacturing practices (GMP) and business management. Designed to increase processor's ability to create value-added, high-quality products like powder, paste and sauces. Developed one training manual for tomato processing and three leaflets. 2 MSc students have been recruited and continuing with their research work

**Way forward:** To complete the shelf life and appropriate package experiments. To complete profitability study for tomato powder. Finalize conducting cooking demonstrations for mama lishe. Exhibition will be conducted to establish initiatives that connect processors to markets.

**Keywords:** Tomato, Drying, Lycopene,  $\beta$ -Carotene, Ascorbic acid

## Processing of goat milk into yoghurt enriched with moringa leaf extracts and marula pulp to improve nutrition, health and food safety

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Botswana continues to face challenges related to food security and rural economic development, compounded by a heavy reliance on imported dairy products. These constraints disproportionately affect women, youth, and marginalized groups in rural communities who often lack access to productive resources. To address these issues, a pioneering dairy goat milk value chain development initiative has been launched in Kang Village, Kgalagadi District—a region characterized by arid conditions and limited agricultural potential. The project aims to empower vulnerable groups, strengthen local economies, and promote food self-reliance while contributing to national efforts to reduce the dairy import bill. Unlike conventional dairy cattle, goats are well-suited to Botswana's harsh, dry environment. As climate-smart livestock, goats are more efficient in their use of water and feed and are resilient to heat stress, making them ideal for smallholder systems. The project supports four beneficiaries (two men and two women, including youth) by providing technical training in dairy goat management, milk collection, hygienic handling, and value-added processing. The intervention introduces a comprehensive value chain model encompassing production, processing, packaging, branding, and marketing. One of the innovative aspects of the project is the development of functional dairy goat products infused with underutilized indigenous medicinal plants traditionally used in Botswana. These include morula (*Sclerocarya birrea*), kgengwe (*Citrullus lanatus*), and mmilo (wild medlar), which are known for their antioxidant, antimicrobial, and anti-inflammatory properties. By integrating these botanicals into goat milk yogurt, soft cheeses, and pasteurized milk, the project offers not only nutritional benefits but also potential health-promoting effects—responding to growing consumer interest in natural, health-enhancing foods. Such product innovation enhances the acceptability and marketability of goat milk, especially among health-conscious consumers, tourists traveling along the Trans-Kalahari Highway, and elderly populations who traditionally prefer goat milk in tea for its digestibility. The project also supports local branding and quality assurance systems to build trust and stimulate demand in both rural and urban markets. The model is designed to be scalable and replicable in similar agro-ecological zones across Botswana. Beyond direct community impact, the project aligns with national and global development goals, including food and nutrition security, gender equity, and climate resilience. It contributes to several United Nations Sustainable Development Goals (SDGs): SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being), SDG 5 (Gender Equality), and SDG 13 (Climate Action). In conclusion, the Kang Dairy Goat Milk Value Chain initiative is a practical example of how integrating traditional knowledge with modern food innovation can uplift rural livelihoods, reduce import dependence, and support inclusive and sustainable development in Botswana.





## CLIMATE CHANGE

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There are 120 million hectares of encroaching bush in Southern Africa. A significant fraction of this waste can be sustainably converted into a smokeless, affordable, clean-burning solid biofuel which can be used as a renewable fuel domestically and industrially. The estimated amount of solid fuel in this area is 359,7 billion tonnes which can be used in power generation through cogeneration or gasification. The encroacher bush is converted through a process called torrefaction, where biomass is dried and 'baked' using hot air, smoke or superheated steam. Bush encroachment of forests and agricultural ecosystems in countries such as Mozambique and Botswana has been identified as a major problem in reducing biodiversity, lower land productivity. The same problem presents a huge biomass energy resource opportunity that can be exploited through various technologies. Agricultural encroacher biomass has been increasing significantly due to drought since the woody bushes are drought resistant. The encroacher biomass is normally uprooted and incinerated adding to the carbon footprint. This project aims to study the different species of encroacher bush most commonly found in Mozambique and Botswana, as well as, to develop and optimize a sustainable technology and process to produce torrefied biomass from agricultural encroacher bush. For that, a theoretical size of encroacher bushes available in Mozambique and Botswana where estimated and samples of various significantly occurring encroacher bushes where collected and characterized. Additionally, a small solar parabola (as a heat generator) and a torrefaction system to produce torrefied biomass were designed, built and optimized in Mozambique and Botswana, respectively. More than 15 species of agricultural encroacher bush were identified in both countries, and 8 were selected to be characterized to assess their suitability for use as efficient biofuel. Furthermore, a performance of a solar heat generator is being evaluated. Results of the samples characterization will be presented.

**Keywords:** encroacher bush, biofuel, torrefaction system



## Sustainable solutions for industrial waste management in Ethiopia: Transforming industrial sludge into energy-efficient bricks, biomass briquettes, and nano-fertilizers

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With a focus on “Sustainable Solutions for Industrial Waste Management in Ethiopia,” our initiative during the past year sought to solve the urgent problem of disposing of industrial sludge while encouraging resource recovery. Sludge from Ethiopian industrial operations contribute to environmental deterioration and public health risks because it is frequently dumped in landfills.

This study investigated cutting-edge techniques for turning industrial sludge into useful goods, such as nano-fertilizers, biomass briquettes, and energy-efficient bricks. The creation of a pilot production machine, intended to maximize the processing of industrial sludge, was a crucial part of our strategy. We were able to improve our techniques and guarantee effective conversion procedures thanks to this prototype. Implementing waste resources that lessen dependency on conventional clay-based products, we were able to successfully transform sludge into long-lasting bricks fit for construction by implementing sophisticated processing procedures. We also created biomass briquettes, which reduce dependency on fossil fuels while improving energy accessibility for nearby areas. The project also looked into the possibility of using nano-fertilizers made from sludge, which demonstrated encouraging results in raising agricultural yields and soil fertility. Significant increases in agricultural output were shown in field testing, giving local farmers a long-term answer and promoting food security. Our results highlight how crucial it is to combine waste management with the objectives of sustainable development. In addition to reducing negative effects on the environment, the effective conversion of industrial waste into valuable goods opens up economic potential in Ethiopia. To promote a circular economy in the area, we advise expanding this strategy even more through public-private partnerships and legislative assistance.

**Key words:** Sustainable Solutions, Industrial Sludge, Resource Recovery, Energy-efficient Bricks, Biomass Briquettes. Nano-fertilizers, Circular Economy, Capacity Building

## Research into optimal formulas for the production of eco-paving stones for urban development

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The Senegalese Chemical Industry (ICS) produces several solid mining wastes, the most abundant of which are phosphogypsum and flint. Flint is stored at a rate of 25% of the raw phosphate ore in Taiba, with a chain that operates continuously for more than 6,000 hours per year. Mining wastes smaller than 200 mm are stored at the Ndomor and Keur Mor Fall waste heaps in the commune of Darou Khoudoss. The annual tonnage produced exceeds 1,500,000 tons. These wastes clog the mining sites and surrounding villages. The study area covers the communes of Taiba Ndiaye, Mboro, and Darou Khoudoss. By reusing these mining wastes, these municipalities can obtain flint aggregates, which constitute an alternative material to expensive basalt, the reserves of which are dwindling. The use of flint waste is used in the formulation of concrete to make paving stones for land development or as load-bearing elements in civil engineering structures. The objective of this project is to contribute to the search for optimal formulas and to strengthen youth self-employment by reusing mining wastes, mainly flint, into paving stones.

To this end, samples of 0/3, 3/8, and 8/16 flint were collected in Mboro, and then identification and formulation tests were conducted in two phases. In the first phase, a minimum of 40% of 0/3 flint waste was used, with cement dosages of 350, 400, and 450 kg/m<sup>3</sup>. These 0/3 flint rejects were reduced in phase 2 to percentages below 15% and 0/3 basalt and dune sand were added with the same cement dosages. After the formulation phase, the selected youths were trained in the production and installation of paving stones. The experimental formulation results revealed that the formulas from the first phase yield tensile strength values between 1 MPa and 3 MPa, and in phase 2, yield values between 3.1 and 4 MPa. These formulas allow the use of the first series in pedestrian and garden path developments, and the second series for paving stone road surfaces. Fifty-seven (57) youths were trained, and 476 m<sup>2</sup> of paving stones were produced and installed at the Darou Khoudoss and Taiba Ndiaye health centers and the Mboro socio-cultural center.

**Keywords:** flint, alternative material, self-employment, Mboro

## Development of affordable and reliable water purifying device for household use in developing countries

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In Nigeria, the scarcity of potable water is a continuous and pressing issue. Only 19% of the population has access to clean and consumable water, according to World Health Organization records. So, waterborne diseases like cholera, diarrhea, dysentery, and hepatitis continue to plague the people in the country. Over 70% of human gastrointestinal diseases in developing nations come from consumption of impure water. This is in spite of the use of some water treatment methods/devices currently available in the market. With this mind, the SGCI Team 3 developed a functional water purification device having the vision of providing clean/potable water, devoid of disease-causing germs (pathogens) at all times that meets the WHO standards. This innovation eliminates waterborne pathogens, heavy metals and chemical pollutants thereby drastically reducing gastrointestinal health related issues associated with contaminated water. The device works in four powerful stages :(a) Mechanical filtration – A fine mesh removes visible contaminants like sand, rust, and dirt, (b) Chemical filtration – An activated carbon layer captures invisible particles, chemicals, pesticides, and heavy metals. ( c) undergoes reverse osmosis treatment for further purification (d) UV purification – A high-intensity UV light further destroys bacteria, viruses, and parasites, ensuring water is not just clean but safe. Other features include pumps to facilitate fast flow of the water during the purification and rechargeable battery that lasts for over one week before recharging through electricity or solar energy. The device is an all-in-one compact, very efficient and effective water purification device that transforms contaminated water into clean, healthy, and consumable drinking water that meets WHO standards. It purifies water from every source (river, stream, ponds, boreholes, etc.) to WHO potable standards. Combining the different treatment methods, the device has about 99% efficient (pathogen-free and chemical substances-free too). No pathogen/chemical escapes all the treatment mechanisms employed in the device. It therefore makes reliable and consumable water available at the household and public places at real time (all times of need) The device will help to eliminate over 50% of the gastrointestinal diseases affecting man in the developing nations. We are engineering a future where clean water will no longer be a privilege, but a guaranteed right to the people.

**Key words:** water, purification, device, pathogens

## Increasing the productivity of cashew-based agroforestry systems and plantations under drought with climate change in the main regions of production of Burkina Faso

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Climate change in Burkina Faso is characterized by a multiplication and amplification of climate extreme events including droughts. The productivity of *Anacardium occidentale* L. (cashew) based agroforestry and plantations systems largely depending on rainfall are therefore vulnerable to droughts under climate change. Also, interactions between cashew and *Sorghum bicolor* L. Moench (Sorghum) in agroforestry systems are not well known. This research development project investigated the effects of water stress on cashew and different options of cashew management on sorghum productivity for formulating recommendations to increase productivity of cashew based agroforestry and plantations systems. The constraints limiting the contractualisation among the different stakeholders of the cashew value chains were investigated for recommendations of business development through the cashew park with productive and drought resilient plants materials. Experiments were conducted in a semi-controlled environment using a complete randomised blocks studying the water regime factor at two (02) levels (water stress and maximal evapotranspiration) and cashew origins (clones) factor at six (06) levels obtained with seeds collected on the best elites cashew trees selected in cashew parks through prospections. Fields experiments were also conducted with cashews of the same age (+15 years) on which different crown pruning levels (0, 25 et 50%) were applied and with cashew of different ages (0-5, 5-10, +15 years) for studying their effects on sorghum growth and yield parameters cultivated in different zones under the crown. Surveys were conducted using questionnaires and focus group discussions with stakeholders of cashew value chain about different aspects of contractualisation. Cashew ages have had significant effects on sorghum performance. Indeed, the older the cashew trees, there is significant reduction of sorghum performance in the different interactions zones under crown. Applying prunings improved sorghum performance under crown with the best performances obtained with the largest pruning fraction. Moreover, the sorghum performance increased as we moved away from the trunk. A cashew morphological and production in grafts diversity was observed and the 06 best cashew elites trees were identified in the cashew parks through prospections. Stakeholders literacy, awareness and information, prioritization of contractual relations between producers and traders and use of formal contracts with specific clauses are recommendations for improving contractualisation in the cashew value chain. About ten students completed their internships. These results suggest the development of agroforestry with cashew in association with sorghum and application of technologies as prunings and sorghum cultivation in areas under crown starting from half the radius of the crown towards outside crown with old cashew trees in the context of climate change. Productive and drought tolerant cashew identified by the project will be vulgarized in the main production regions through the development of cashew parks. In perspectives, on the one hand, information, awareness-raising and training actions through the different cashew professional organizations will be carried out and future research will be conducted consisting in monitoring the performance of productive and drought-tolerant cashew identified by the project and planted in parks on the other hand.

**Keywords:** agronomy, forestry, yield, temperature, rainfall

## A multi biomass-fueled continuously running stove and its environmental and social impact

*Dr. Sheriff Kamara*

**Background and Significance:** There are 2.3 billion people in developing countries that use solid biomass fuels on traditional open fire stoves for cooking and heating. Furthermore, about one billion people from sub-Saharan Africa countries, Sierra Leone included, still use cooking fuels that are highly polluting. In Sierra Leone, inefficient cooking methods are still used by over 80% of the population that are involved in cooking and heating. Inefficient burning of biomass can emit pollutants that are harmful to human health and the environment. Moreover, children in rural settings, especially girls, are involved in collecting fuels for cooking, which exposes them to risks such as violence, sexual harassment and early drop out from school. Over the years, researchers have come up with more efficient methods of cooking, for instance, liquefied petroleum gas stove and electric hot plates. However, lack of electricity poses a challenge to using electric devices, and LPG is expensive, especially for rural settlements. There is need to proffer solutions to help solve these issues bothering on economic, social and environmental concerns. Studies have shown that improved cookstoves pollutes less and use less fuel. However, there is need for further improvement: ease of use, cooking time, continuous operation and thermal efficiency. This study is undertaken to come up with a more efficient cookstove that pollutes less but improves lives and livelihoods.

**Methodology:** The design of the stove concentrated on improving ignition and combustion, as better results on these factors can reflect positively on cooking time and efficient fuel consumption. Thus, one focus was to design a grate that is capable of allowing sufficient primary air to aid fuel combustion, while combustion chamber design was concentrated on the possibility of fuel to be fed horizontally and vertically, thereby making it possible for different solid biomass fuel to be burnt more efficiently. Seven prototypes were fabricated entirely from mild steel that is widely available. The prototype stove containing charcoal of known weight used as fuel. Two kilo grammes of water in a pot was placed atop till it boils. The time taken to boil and the amount of fuel consumed were recorded. The same processes were carried out on the widely used wonder stove in the country, and both results compared.

**Key findings:** The results reveal: the prototype stove was three times faster in terms of ignition; cooking time was two times faster and; a 20% reduction in fuel use. Also, totally wet charcoal and wood were combusted faster in the prototype stove, though ignition was slower compared to dry biomass fuel. The prototypes were also given to four women and were entreated to use the stove for a week and report their findings. Their findings show slight variations in results in which the prototype proved to be more efficient.

**Conclusion and Implications:** The final design production of the stove is expected to be more thermal efficient leading to a reduction in cooking time and fuel use. Thus, children will make fewer visits to fetch wood, thereby reducing the amount of tree cut down and a reduction in pollution. Improvement in ignition, cooking time and fuel use are factors that required to attract investment opportunities.

**Key words:** Cookstove, Ignition, Pollution, Biomass, Efficiency



## Development of hydrogel technology to mitigate the effect of drought in desert areas of northern Nigeria

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**Background and Significance:** The United Nations Sustainable Development Goals underscore the critical urgency of combating climate change and advancing the preservation and sustainable management of terrestrial ecosystems. In alignment with this mandate, this project focuses on the utilization of biodegradable, nutrient fortified super absorbent polymer hydrogels to mitigate seedling mortality induced by heat stress during periods of temporary drought across drought prone regions of Northern Nigeria.

**Methodology:** A structured KoboCollect questionnaire and transect walks were conducted across Dambatta and Dawakin Tofa LGAs in Kano State to assess farmer persona and perceptions on the impact of drought on their farm operations and livelihoods. Laboratory experiments were carried out to formulate a super absorbent hydrogel from a combination of polyacrylamide (anionic), sodium polyacrylate, sodium alginate, chitosan, carboxymethyl cellulose, together with polyvinyl pyrrolidone and carbon black thermal stabilizers, Cross linkers used included 25% glutaraldehyde, calcium chloride, and borax. The hydrogel was fortified with nutrient protein hydrolysates (NPH) derived from poultry waste and ammonium sulfate mixed in a 1:1.5 ratio. Various tests were carried out: water retention and swelling tests using various particle sizes, sorption-desorption heating trials at 40–60 °C, FTIR and scanning electron microscopy (SEM) for stability and morphology, LD<sub>50</sub> toxicity tests on mice at doses from 0.5 to 50 ml/kg. Finally, a simulated 3-week drought trial on water sensitive cucumber seedlings was conducted to assess hydrogel performance.

**Key Findings/Preliminary Results:** The data revealed that perennial temporary drought typically lasts 3-8 weeks after first rainfall leading to significant seedling losses. Most respondents were married males aged CI = 40-57 years with secondary education. Over 70% of respondents earn between N 50,000 – N 200,000 monthly and spend between N 74,646 – N 148,905 on organic compost for soil fertility improvements. Early planting starts in June coinciding with first rains while late planting in August or September is not considered viable. There is the consensus no effective drought mitigation strategies currently exist in the study area. Laboratory results showed high water retention: 1 g of dry hydrogel retained 48.18 g of water, released after 3 days to a final weight of 0.98 – 0.67 g at ambient temperature or 4 hours at 60 °C. Hydrogel particle size with best swelling and water retention performance ranged from 0.2 – 0.45 mm. Furthermore, soil mixed with 1 g formulated hydrogel retained over 72% more moisture than untreated soil samples. FTIR and SEM confirmed structural stability after 7 and 4 sorption and desorption heating cycles at 40 and 60 °C respectively. The hydrogel was non-toxic, and cucumber seedlings grown in hydrogel treated soil survived over three weeks without watering, compared to one week for controls.

**Conclusion and Implications:** The formulated hydrogel demonstrated strong physicochemical adaptability to drought-associated environmental thermodynamics, remaining stable under high-temperature stress while enhancing soil fertility and seedling growth. These findings suggest that the formulated hydrogel offers a viable and sustainable solution for mitigating drought-induced crop failure, has the potential for degraded land reclamation and restoring agricultural productivity in Northern Nigeria and similar climates.

**Key Words:** Hydrogel, drought, protein hydrolysates, soil fertility, super absorbent polymer

# Rethinking urban sanitation through innovative and low-cost climate-resilient wastewater treatment systems

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The preferred sanitation system in urban areas of Malawi is the flush toilets connected to septic tanks or sewer systems. Climatic factors and inadequate operation and maintenance programs compromise the functionality of these systems. In view of this, alternative and climate-resilient sanitation technologies are urgently needed to solve the urban sanitation challenge. Constructed wetlands (CWs) are a promising alternative to conventional sewerage systems. CWs can be integrated with other wastewater treatment technologies. However, several challenges persist when using CWs, including clogging media beds, potential challenges with waste water purification in cold climate and inadequate design, construction and management practices that can hinder the performance and longevity of CWs. To address such challenges, coagulating the wastewater before it enters CWs can help decrease the solid concentration, effectively minimising clogging challenges. This study assessed the coagulating effectiveness of *Moringa oleifera* (MO) seed powder as an alternative to commercially available synthetic coagulants. In this study alum was used. Wastewater samples were collected from the Soche wastewater treatment plant in Blantyre. Various concentrations of MO seed powder were tested alongside alum using a jar test method. Raw and treated wastewater samples were analyzed for pH, turbidity, total suspended solids (TSS) and heavy metals. MO produced removal efficiencies of TSS (62%) and turbidity (65%). Furthermore, both MO and alum demonstrated comparable efficiencies in reducing the concentration of heavy metals (Fe and Zn). Optimum removal efficiency was noticeable at lower doses of 0.2 g/L to 0.3 g/L. For pH results, MO treated waste water maintained a pH that was within the recommended range of 6 to 9 while the results of pH levels in alum-treated wastewater indicated a shift towards acidity with increasing dosage. This could have potential negative effects on aquatic organisms and supporting biological activities in the CW. These findings highlight the potential of incorporating natural plant coagulants in wastewater treatment, ultimately enhancing pollutant removal while offering cost-effective and sustainable solutions for urban sanitation challenges in Malawi.

**Keywords:** Urban-sanitation, Constructed-wetlands, *Moringa oleifera*, Coagulation, Wastewater-treatment.

## Caractérisation et utilisation cosmétologiques des argiles locales (COSMETARGILE)

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**Background and Significance :** Au Sénégal, l'industrie de la cosmétique (masque facial, savons et poudre teintée) génère des ressources financières estimées à plusieurs milliards de francs par année. Cette manne financière est extravertie car la majeure partie de ces produits sont importés. L'objectif de ce projet de recherche est de répertorier différentes variétés d'argiles dans le pays aux fins de les caractériser et ainsi en faire des formulations pour leur utilisation dans l'industrie de la cosmétologie.

**Methodology:** Les produits argileux ciblés portent sur une panoplie d'argiles locales susceptibles d'être utilisées après un traitement mécanique et physico-chimique. Ainsi, une campagne de cartographie et d'échantillonnage a permis de collecter cinq types d'argiles sur l'étendue du territoire sénégalais. Il s'agit d'argiles provenant de Bakel (Est du Sénégal), de Keur Diatta dans la région de Kaolack (Centre du Sénégal), de Diagobel dans la région naturelle de Casamance (Sud du Sénégal), des attapulgites de Allou Kane dans la région de Thiès (Ouest du Sénégal) et des tufs volcaniques dans la région de Kédougou (Sud-Est du Sénégal). La localisation de ces ressources minérales est suivie d'une campagne d'échantillonnage puis de caractérisation. Ainsi, des études géochimiques par la spectrométrie par fluorescence aux rayons X (EDXRF), physiques (pH, masse volumique, distribution granulaire, argilosité) et mécaniques (indice portant Proctor) ont été réalisées dans le but de connaître les différentes propriétés des argiles, ainsi voir leur conformité pour les utilisations ciblées.

**Key Findings / Preliminary Results:** La connaissance de ces propriétés avec les besoins ciblés a permis de faire des formulations de savons afin d'optimiser certains paramètres d'utilisation en cosmétologie. Les argiles utilisées sont des matériaux de classes granulaires 0/2 mm, inactives au vu des valeurs de bleu de méthylène adsorbée (VBS) obtenues, sauf pour les attapulgites (peu actives) qui présentent une valeur de VBS de 4 en moyenne. Dans le cadre de la formulation des savons, plusieurs formules ont été réalisées entre l'huile palmiste, l'huile d'arachide et les argiles. Pour chaque savon, une quantité de 50g total en huile est utilisée. Les pourcentages d'huiles palmiste et d'arachide prennent en compte le facteur INS qui doit être compris entre 146 et 150. Pour la fabrication des savons, 60g d'huile palmiste et 40g d'huile d'arachide sont mélangés avec la soude mise en solution dans 15 ml d'eau distillée. La détermination de la quantité de soude nécessaire à la saponification complète des corps gras est déterminée en multipliant la quantité de chaque corps gras (50g) par son indice de saponification exprimé en NaOH. Les quantités d'argile correspondant à 5 et 10% en ajout par rapport à 50 g total d'huile sont ajoutées. Les savons sont mis en maturation pendant trois semaines avant de les caractériser.

**Conclusion and Implications:** Les études de la stabilité de la mousse sont en cours pour évaluer la capacité des savons à générer de la mousse sous l'effet d'un écoulement (chute libre) et la persistance de cette mousse dans le temps. Il en est de même de l'étude du taux d'érosion des savons en contact avec l'eau. La deuxième partie des travaux est consacrée à la formulation des masques faciaux.

**Keywords:** argiles, cosmétologie, formulation



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## HEALTH



# Production of bacteriocins as antimicrobial active pharmaceutical ingredients from locally isolated lactic acid bacterial strains

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**Background and Significance:** The rise of antimicrobial resistance (AMR) poses a severe global health challenge, with increasing failure of conventional antibiotics. This crisis calls for innovative and sustainable antimicrobial agents. Bacteriocins, ribosomally synthesized antimicrobial peptides produced by lactic acid bacteria (LAB), represent a promising class of bioactive compounds with specific activity against pathogenic microorganisms. Unlike traditional antibiotics, bacteriocins are heat-stable, non-toxic, and show minimal risk of inducing resistance. Ethiopia's diverse ecological zones and rich fermentation traditions offer a largely untapped reservoir of microbial biodiversity that can be harnessed for novel bacteriocin discovery. This project aims to isolate, characterize, and evaluate indigenous bacteriocin-producing LAB strains from traditional Ethiopian fermented products and environmental niches, with the goal of developing novel antimicrobial APIs.

**Methodology:** Between March and July 2024, 180 samples were collected from 12 ecologically distinct sites across Ethiopia, including the lowlands of Afar, the highlands of Bale, and temperate zones like Addis Ababa. Sample types included yogurt, raw milk, traditional fermented beverages (Tella, Tej), and soil. Bacterial isolation was conducted using MRS and M17 agars under anaerobic conditions. A total of 72 LAB isolates were selected based on colony morphology and subjected to standard primary and secondary biochemical assays, including Gram staining, catalase test, and acid production on TSI agar. Antimicrobial activity was evaluated using the agar well diffusion method against six clinically relevant indicator strains: *Enterococcus faecalis*, *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, and *Proteus mirabilis*. Cell-free supernatants (CFS) were tested before and after pH neutralization and Proteinase K treatment to confirm the presence of bacteriocin-mediated activity.

**Key Findings/Preliminary Results:** Out of 72 LAB isolates, 69 were Gram-positive rods and 3 were Gram-positive cocci. Most isolates were catalase-negative and exhibited acid production on TSI agar, consistent with LAB physiology. Preliminary screening showed that 37 isolates inhibited *E. faecalis*, and 20 isolates were active against *P. aeruginosa*, with inhibition zones ranging from 13 mm to 25 mm. No significant inhibition was observed against *E. coli*, *S. aureus*, *K. pneumoniae*, or *P. mirabilis*. Antimicrobial activity that persisted after neutralization and was lost upon protease treatment confirmed the presence of proteinaceous antimicrobial compounds-putative bacteriocins.

**Conclusion and Implications:** The study successfully demonstrated the presence of potent indigenous LAB strains capable of producing bacteriocins with targeted antimicrobial activity, particularly against Gram-positive pathogens. These findings highlight the potential of Ethiopian fermented food ecosystems as a resource for novel antimicrobial compounds. Further purification, molecular characterization, and in vivo efficacy studies are warranted to validate these bacteriocins as viable active pharmaceutical ingredients. This research supports the broader goal of addressing AMR through sustainable, locally sourced biotechnological innovations.

**Keywords:** Antimicrobial resistance, Bacteriocins, Lactic acid bacteria, Ethiopia, Active pharmaceutical ingredients.

## Recherche de l'ADN tumoral circulant dans la détection des cancers chez les personnes infectées par le HPV en Côte d'Ivoire (ACiHPV-CI)

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**Background and significance:** Les papillomavirus humains (HPV) sont des virus épithéliotropes ayant un tropisme cutané ou muqueux et le principal tissu touché est le col de l'utérus (CU). On distingue les HPV à bas risque et ceux à haut risque oncogénique. Le portage d'un génotype HPV même à haut risque n'induit pas systématiquement l'apparition de cancer. L'ADN tumoral circulant (ADNtc) plasmatique du HPV est un biomarqueur précoce de choix, mais vu l'importante diversité génomique en Afrique, y sera-t-il efficace ? L'objectif de cette étude est d'évaluer l'ADNtc dans la détection des cancers HPV induit afin d'envisager son implémentation avec succès en Côte d'Ivoire. O

**Methodology:** Cette étude transversale porte sur des sujets infectés par le HPV atteints ou non de cancer du CU (CCU) et des sujets témoins négatifs non infectés par le HPV. Les participants bénéficient d'examens cliniques, anatomo-pathologiques et biologie moléculaire. Deux PCR sont réalisées: une pour la recherche du HPV au CU et l'autre pour rechercher l'ADNtc plasmatique. Les sujets cancéreux ayant une PCR HPV négative bénéficieront du séquençage. Il y a une étape de préinclusion avant l'inclusion.

**Key findings:** Les résultats préliminaires portent sur 23 participantes testées en double. L'âge moyen était de  $48,9 \pm 7,4$  ans avec les extrêmes de 36 et 75 ans. Parmi elles, 56,5% (n=13/23) proviennent de l'anatomie pathologie et 43,5% (n=10/23) du projet SUCCESS. Pour les PCR, celle pour la détection des 28 génotypes HPV, bien que positives pour les témoins positifs du fournisseur et le contrôle interne, les 2 premiers échantillons testés étaient négatifs. L'optimisation est en cours en vue de s'assurer du succès de ces réactions. Les PCR ADNtc quant à elles ont été satisfaisantes. Celles du fragment ADN de HPV16 étaient positives pour 23,1% (n=3/13) des sujets cancéreux provenant de l'anapath et négatives pour toutes les participantes (100%) sans cancer avéré. Les PCR du fragment de HPV33 étaient positives pour toutes les participantes à HPV positives sur le CU et négatives pour les 2 à HPV négative au CU. Les obstacles actuels sont des difficultés de recrutement. Pour ce faire, nous avons contacté avec succès des sites cliniques non prévus dans le protocole de l'étude (CIRBA et CNTS).

**Conclusion and implications:** L'ADNtc du HPV33 serait un meilleur marqueur de dépistage du CCU en Côte d'Ivoire. La grande majorité des femmes ayant le HPV au CU aurait un CCU en cours de développement. Les résultats finaux clarifieront mieux la tendance.

**Mot clé :** ADNtc, HPV, Col de l'utérus, cancer, dépistage

## Mise au point d'un complément alimentaire phyto-estrogénique à base des feuilles de *Manihot esculenta* Crantz (Euphorbiaceae) pour la prise en charge des symptômes liés à la ménopause

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La ménopause est une étape physiologique normale dans la vie de la femme, marquant la fin de la fonction ovarienne. Toutefois, elle s'accompagne de nombreux troubles, souvent difficiles à supporter tels que bouffées de chaleur, céphalées, fatigue, douleurs articulaires et musculaires, troubles de l'humeur, baisse de la libido, troubles du sommeil, maladies cardiovasculaires et ostéoporose. Ces symptômes, variables en intensité selon les femmes, peuvent altérer la qualité de vie de ces dernières, affecter leur activité socioprofessionnelle et modifier leur perception de la santé. Longtemps considérés comme une fatalité silencieuse, les symptômes de la ménopause sont aujourd'hui davantage exprimés. De nombreuses femmes n'acceptent plus ces désagréments comme inévitables et recherchent désormais des solutions de prise en charge holistiques, naturelles et non hormonales, adaptées à leurs besoins. Face à ces attentes, il devient essentiel de proposer une prise en charge plus complète, qui considère la femme dans sa globalité. L'étude de nouvelles ressources thérapeutiques d'origine végétale, riches en composés bioactifs comme les phytoestrogènes, représente une piste prometteuse pour le développement d'approches complémentaires permettant de soulager efficacement les troubles liés à cette période de transition hormonale. Ce projet s'inscrit dans ce contexte et vise à améliorer l'état de santé et le bien-être des femmes en période de ménopause par la mise au point d'un complément alimentaire riche en phyto-estrogènes et efficace contre les symptômes liés à la ménopause. Suite à des entretiens semi-structurés avec l'ANADER (Agence Nationale d'Appui au Développement Rural) et des cultivateurs de manioc, des feuilles de deux variétés de manioc ont été récoltées dans trois localités productrices. Ces feuilles, lavées et séchées à une température de 16 °C ont été soumises à des analyses physicochimiques et phytochimiques afin d'évaluer leur qualité, leur efficacité potentielle et leur sécurité pour un usage thérapeutique. Les résultats montrent que les feuilles de ces deux variétés sont riches en composés bioactifs d'intérêt pour la prise en charge de la ménopause. Elles renferment des polyphénols, des flavonoïdes, des tanins, des isoflavones, mais aussi des vitamines (C, D, B), des acides aminés essentiels, des minéraux (potassium, calcium, phosphore) et des acides gras de type oméga nécessaires pour une meilleure gestion des symptômes de la ménopause. Elles présentent par ailleurs une activité antioxydante notable. Les tests de toxicité ont révélé l'innocuité des extraits à des doses allant de 125 à 1000 mg/kg, confirmant ainsi leur potentiel sécuritaire. Les deux variétés sont efficaces aux doses de 250 mg/Kg pour les extraits hydroéthanolique et de 1000 mg/Kg pour les extraits aqueux. Sur la base de ces résultats, un complément alimentaire a été formulé dans l'objectif de soulager efficacement les symptômes de la ménopause. Ce projet ouvre des perspectives économiques pour les producteurs de manioc, en leur permettant de valoriser les feuilles, généralement jetées, et d'augmenter ainsi leurs revenus. Enfin, ces résultats constituent une base prometteuse pour l'industrie pharmaceutique, qui pourrait s'en inspirer pour le développement de nouvelles formulations naturelles dédiées à la santé de la femme. Des études complémentaires sont envisagées pour affiner la formulation et évaluer cliniquement son efficacité.

**Mots clés:** complément alimentaire, femmes, manioc, phyto-estrogènes, symptômes de la ménopause

## Adsorptive removal of diclofenac sodium from water: iochar nanocomposite approach

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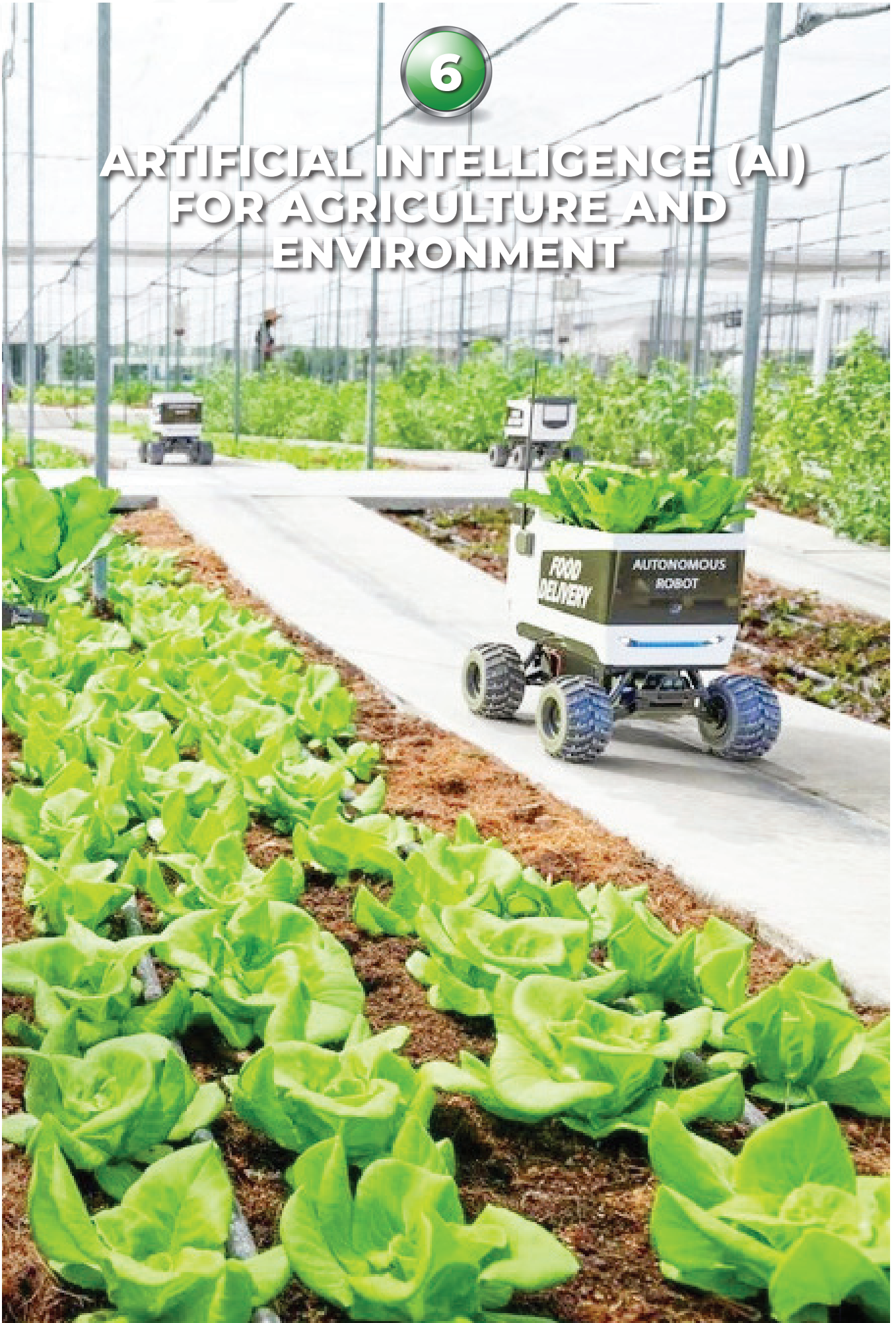
This study explores the solventless synthesis of zinc oxide (ZnO) nanostructures using zinc oleate as a precursor. The process offers a simple and stable route to produce ZnO with controlled morphologies. Thermal decomposition at 350 °C resulted in incomplete conversion, while complete transformation to the zincite phase with a preferred (101) orientation occurred at 400 and 450 °C. Scanning electron microscopy revealed nanowires ( $\sim 90 \pm 9$  nm diameter,  $12 \pm 2$   $\mu$ m length) at 400 °C and nano-petals at 450 °C, highlighting the effect of temperature on morphology. Energy-dispersive X-ray (EDX) analysis confirmed a near 1:1 Zn to O atomic ratio in both samples. Optical studies showed band gaps of 4.76 eV (nanowires) and 4.73 eV (nano-petals), both blue-shifted from the bulk ZnO value of 3.44 eV, suggesting quantum size effects. The ZnO nanowires were mixed with coconut husk biochar at 5% loading to form the biochar nanocomposite which had a honey comb morphology. The biochar nanocomposite was used to adsorb diclofenac sodium from polluted water. The choice of the adsorption technique for this study stems from its operational simplicity and low cost as compared to the other known techniques. The biochar nanocomposite removed 98% of the diclofenac sodium from the polluted water.

**Keywords:** adsorption, biochar nanocomposite, diclofenac sodium, ZnO.



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## ARTIFICIAL INTELLIGENCE (AI) FOR AGRICULTURE AND ENVIRONMENT





## Advancing agricultural sustainability: Leveraging artificial intelligence for optimal livestock security and productivity

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Livestock theft and inadequate animal identification systems severely hinder agricultural productivity, livestock security, and financial inclusion across Sub-Saharan Africa. Traditional methods in Malawi, Zambia, and Zimbabwe like ear tagging, hot iron branding, and ear notching are easily tampered with or removed, offering limited traceability and restricting access to vital financial services for smallholder farmers. This project addresses these critical challenges by developing and testing a secure, mobile-based digital cattle identification system leveraging advanced biometric technologies, specifically facial recognition and nose print analysis. The methodology involved collecting extensive datasets, including over 900 high-resolution images of cattle faces and nose patterns across the three countries, which were used to train convolutional neural networks (CNNs) for robust image recognition. A minimum viable prototype (MVP) was developed in each country through a design-thinking approach, emphasizing co-creation and iterative feedback from cattle farmers. Validation of the MVP at the joint project review and app testing workshop in Zambia demonstrated promising initial results, achieving approximately 80% identification accuracy. Further testing and refinement are actively underway across Malawi, Zambia, and Zimbabwe. Preliminary findings affirm the technical feasibility and field acceptance of AI-powered biometrics as a scalable, tamper-proof alternative to traditional methods. Beyond enhancing cattle traceability for disease surveillance and regulatory compliance, the system lays the groundwork for policy reform and the development of inclusive livestock insurance schemes. The project also significantly contributes to capacity building by training postgraduate students and national technical teams in AI and machine learning applications. Ultimately, this initiative marks a transformative step towards fostering a resilient, digitally enabled livestock sector in Sub-Saharan Africa, empowering farmers with secure animal identification and greater access to value-added services.

### Keywords

Livestock Identification, Biometric Technologies, Artificial Intelligence, Traceability, Sub-Saharan Africa

## Collection of phytosanitary and yield data of cashew and mango using artificial intelligence

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Les filières mangue et anacarde jouent un important rôle socio-économique au Burkina Faso. Les maladies et les ravageurs engendrent d'énormes pertes économiques. Ce projet veut proposer des solutions innovantes utilisant des techniques d'Intelligence Artificielle (IA) pour l'identification automatique des principales maladies (déperissement des arbres, bactériose et anthracnose sur les feuilles et fruits et tiges) ainsi que les principaux ravageurs (mouches de fruits et la cochenille farineuse) de ces arbres. L'identification automatique des maladies se fera grâce à des algorithmes d'apprentissage automatique appliqués sur des images aériennes d'anacardiens et de manguiers collectées à l'aide des drones. Par la suite, d'autres techniques d'IA seront utilisées sur les images combinées à d'autres données collectées pour une estimation du rendement dans les plantations au Burkina Faso. A termes, ces solutions (IA) permettront d'améliorer le système de collecte de données qualitative et quantitative pour l'identification automatique des maladies et ravageurs puis l'estimation du rendement des anacardiens et manguiers avec peu de ressources financières, humaines et de temps. Ces solutions (IA) consisteront tout d'abord à collecter des images des plantes saines et des plantes affectées par les principales maladies et ravageurs. Cette collecte se fera par des smartphones, des tablettes et des drones. Les images seront ensuite labélisées/ étiquetées en fonction du type de nuisible ou maladie. Des algorithmes d'apprentissage automatique ou d'apprentissage profond tels que les réseaux neuronaux convolutifs (CNN) seront entraînés sur l'ensemble des images labélisées pour la détection des nuisibles et des maladies. Enfin, une application embarquant le meilleur algorithme de détection des nuisibles sera conçu puis déployée et un système de recommandation sera intégré à cette dernière afin de proposer le traitement phytosanitaire approprié à chaque nuisible. Des technologies de lutte contre ces bioagresseurs sont disponibles. Cependant, les producteurs ont des difficultés pour identifier les symptômes des maladies et les dégâts liés aux ravageurs. En outre, ils méconnaissent les bonnes techniques de gestion intégrée de ces bioagresseurs limitant le choix ou une confusion des méthodes de lutte. Cette application pourra être très bénéfique pour les agriculteurs. En effet, elles peuvent permettre de collecter des données qualitative et quantitative pour l'identification automatique des maladies, ravageurs et les rendements des anacardiens et manguiers avec peu de ressources financières, humaines et de temps. Les applications peuvent permettre un suivi en temps réel de l'état de santé des plantes en permettant une détection rapide et précise des nuisibles. Ainsi, les agriculteurs peuvent réagir promptement en prenant les mesures de contrôle appropriées, ce qui réduit les pertes de récolte et améliore la productivité. En sommes, ces applications ont le potentiel de révolutionner les pratiques de gestion des maladies et ravageurs des plantes et de soutenir les efforts visant à relever les défis de la sécurité alimentaire.

**Mots clés :** Mangue, anacarde, principales maladies, principaux ravageurs, Intelligence Artificielle (IA), Burkina Faso.

## Innovate-4-Water: A systems innovation approach to urban water security in arid Namibia

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Rapid urban expansion and increasing climate variability are putting unprecedented pressure on urban water systems across Africa, with particularly severe effects in arid and semi-arid countries like Namibia. Namibia's water scarcity is compounded by highly variable rainfall, limited infrastructure resilience, and operational challenges faced by local authority water utilities. Inadequate data systems, ageing infrastructure, and fragmented governance frameworks have hindered municipalities from effectively addressing water loss, resulting in high Non-Revenue Water (NRW) figures. This study responds to this challenge by rethinking urban water security through an integrated approach structured around four interconnected pillars: (i) analysis of water utility governance mechanisms and institutional performance; (ii) evaluation of infrastructure repurposing, specifically stormwater harvesting and urban design interventions; (iii) deployment of artificial intelligence (AI) and Internet of Things (IoT) technologies for real-time monitoring of water distribution networks; and (iv) impact evaluation to promote uptake and policy alignment. Using an action-oriented, interdisciplinary methodology, the research combined technical fieldwork, stakeholder participation, and iterative co-design sessions. Local authorities in Ongwediva, Rundu, and Windhoek were engaged alongside Namibia's bulk water supplier and relevant ministries to ensure practical relevance. A structured assessment of key national policies, legislative instruments, and municipal mandates revealed systemic enablers and barriers to improved service delivery. Insights from this governance analysis informed the development of context-specific service delivery indicators and surfaced the gap between regulatory frameworks and on-the-ground realities. One notable result is the repurposing potential of urban stormwater as key hydrological sites contain no major pollutants, rendering it generally safe for potable use after basic treatment, an insight that can transform urban design and resilience strategies. However, data gaps remain in certain areas, highlighting the need for systematic monitoring. The project co-developed an innovative AI-IoT architecture consisting of five interlinked layers: sensing and measurement, wireless communication, edge processing, cloud analytics, and decision support. The prototype design emphasises local processing and anomaly detection, supported by user-friendly dashboards that enhance municipal responsiveness to leaks and pressure losses. Results from stakeholder engagements confirmed that most local authorities currently estimate NRW using outdated financial proxies rather than real-time field measurements, relying heavily on customers to report leaks. Validation exercises demonstrated alignment between the proposed smart system and the operational realities of the target municipalities, providing a clear pathway to reduce NRW. An integrated impact assessment framework was developed, applying innovation impact indicators (III) that focus on policy frameworks, infrastructure repurposing, and technological advancement. The approach combines surveys, dashboard analytics, and policy influence strategies to produce measurable results. Key outcomes include a digital benchmarking framework, predictive analytics for continuous performance tracking, and real-time dashboards for utilities and policymakers, each of which enables smarter decision-making and improved accountability. Preliminary results underscore that technological innovation alone is insufficient. Success depends on an enabling environment comprising improved governance structures, evidence-based policy reforms, adequate funding, and strengthened technical capacity within local authorities. By combining smart technologies, nature-based solutions, and institutional reforms, this study contributes a novel, evidence-based, multi-dimensional innovation model, that integrates governance, urban design, and intentional impact measurement. This model offers a scalable and inclusive pathway to strengthen urban water resilience, reduce NRW, and close persistent service delivery gaps, positioning Namibia's urban centres as potential exemplars of adaptive water security in arid and semi-arid contexts.

**Keywords:** Artificial Intelligence, Internet of Things, Urban Water Security, Water Governance, Smart Infrastructure

## Vehicle pollution monitoring system in Rwanda

*Emmanuel Tuyizere*

Air pollution from vehicle emissions poses a major threat to both environmental sustainability and public health in Rwanda and globally. Despite the country's proactive effort such as the 2016 Air Quality Law and targets aligned with Euro 4 emission standards. Rwanda continues to face challenges in real-time monitoring of vehicle emissions. Current methods rely heavily on periodic inspections, leaving a critical gap in continuous emissions tracking. Greenalytic Motors Ltd, a Rwanda-based startup, is bridging this gap through the development of its Vehicle Pollution Monitoring System (VPMS), an innovative hardware and software solution that provides continuous, real-time monitoring of harmful emissions such as Particulate Matter (PM), Carbon monoxide and Nitrogen Oxides (NO<sub>x</sub>). VPMS is designed to empower governments, fleet operators, and vehicle owners to monitor emissions, ensure compliance, and take proactive steps toward achieving cleaner air. The idea for VPMS emerged from extensive emissions testing conducted in partnership with the Rwanda National Police, university of Rwanda and Beno holding ltd at the Vehicle Inspection Center in Kigali. Over 1,500 cars, 192 school buses, and 400 motorcycles were tested, revealing widespread emissions violations. These findings informed the design and development of VPMS, which underwent multiple prototype iterations tested under real-world conditions to ensure precision, reliability, and sensor accuracy. Key milestones achieved include the development of a validated Minimum Viable Product (MVP), implementation of a real-time dashboard platform, and establishment of a local production facility. Greenalytic Motors has also secured Intellectual Property (RW/U/2023/25) and Data Controller Certification (001/1677/1224) from the National Cyber Security Office, reinforcing its commitment to innovation and data protection. The impact of VPMS is expected to be transformative. By enabling real-time emissions tracking, the system will enhance regulatory compliance, improve public health, and support Rwanda's environmental goals. Looking ahead, Greenalytic Motors aims to establish long-term operations in Rwanda and expand its reach across the region and beyond. Strategic recommendations include integrating VPMS into national policy frameworks, offering adoption incentives like tax exemptions, and mobilizing additional funding for mass production and advanced R&D as we plan to improve the device and add advanced features, such as fuel level monitoring, speed governance, and On-Board Diagnostics (OBD).



# AI AND DIGITAL APPLICATIONS IN HEALTH





# Developing a machine learning predictive model for neonatal birth asphyxia utilising data from selected health facilities of Zambia: A nested study in the AI trilateral call for Zambia, Malawi and Zimbabwe

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**Background and Significance:** Neonatal asphyxia defined remains one of the most significant causes of newborn mortality worldwide with over one million deaths each year (WHO, 2024; Moshiri et al., 2019). In Zambia, asphyxia continues to contribute to neonatal deaths even though routine perinatal data collection is in place at most health facilities. However, existing clinical tools are limited in Zambia and other low resource settings making it a challenge to effectively utilise the data. Machine learning models that leverage this data have the potential to improve perinatal care and neonatal outcomes.

**Methodology:** A retrospective cohort study of 21,366 live births (2001 – 2025) across 14 public hospitals was conducted. After data cleaning the sample comprised 19,906 neonates and 31 features encompassing vital signs, congenital defect indicators, temporal and geographic variables. The dataset was partitioned into an 80% training set (n = 15,924; further split 70:30 into model development and validation) and a 20% evaluation set (n = 3,982). Logistic regression, a neural network, a tuned random forest, and two XGBoost models (Bayesian-optimised and grid-searched) were trained. Model performance was assessed on the evaluation set.

## Key Findings/Preliminary Results

The data had high class imbalance with only 8% of observations being positive for asphyxia. No imbalance-correction methods were applied to get a real world understanding of our model's performance. The Bayesian-optimised XGBoost model achieved the highest discrimination (AUROC 0.907), with accuracy 87.0%, sensitivity 70.4%, specificity 88.4%, precision 33.4%, and F1-score 0.50. The grid-searched XGBoost attained AUROC 0.904 (accuracy 90.2%, sensitivity 60.8%, specificity 92.7%, precision 40.7%, F1-score 0.50), while the tuned random forest yielded AUROC 0.906 but lower sensitivity (30.7%) and higher specificity (98.3%). Logistic regression showed poor performance (AUROC 0.614, 0% sensitivity), and the neural network exhibited high recall (93.2%) but inadequate specificity (33.8%) and overall accuracy (38.3%). Feature importance analysis of the Bayesian-optimised XGBoost model identified birth facility, third-minute oxygen saturation, cardiovascular defect presence, district of birth, second-minute oxygen saturation, temperature, and first-minute saturation as the most influential predictors.

## Conclusion and Implications

The Bayesian-optimised XGBoost model's ability to identify over 70% of at-risk infants at an overall accuracy of 87.0%, despite severe class imbalance, proves its potential clinical importance. Ongoing work focuses on addressing imbalance to further improve recall and precision. Integration of this predictive model with AI and/or IoT tools in hospitals could enable real-time risk identification, targeted intervention, and ultimately reduce neonatal mortality in Africa.

**Keywords:** Neonatal asphyxia, Machine learning, XGBoost, Class imbalance, Predictive modelling

## A digital intervention for the early detection and prevention of depression and suicide among youth in Kenya

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University students in low-resource settings are increasingly vulnerable to mental health disorders, with depression and suicidal ideation presenting significant threats to their well-being and academic performance. Inadequate access to psychological services, compounded by stigma and low mental health literacy, exacerbates these challenges. This study introduces *AkiliBora*, a mobile-based digital intervention designed to facilitate early detection, prevention, and support for depression and suicide among Kenyan youth. The *AkiliBora* application integrates an AI-powered chatbot for real-time interaction, the PHQ-9 self-assessment tool, access to tailored mental health resources, and a built-in alert system that notifies healthcare providers when users are at risk. The solution was co-developed through a participatory design process involving mental health practitioners, psychologists, technologists, and university students. To evaluate its efficacy, a 12-week randomized controlled trial was conducted with 148 university students, randomly assigned to intervention and control groups. Quantitative outcomes were assessed using standardized psychometric tools. Data were analyzed using t-tests and ANOVA to determine statistical significance. Findings demonstrated that participants in the intervention group exhibited significantly lower perceived stress levels ( $P < .001$ ), with sustained effects observed at follow-up ( $P < .03$ ). Significant differences were also found between the groups across all primary outcomes related to depression prevention and early detection (all  $P < .04$ ), with effect sizes ranging from moderate (Cohen's  $d = 0.59$ ) to large ( $d = 1.24$ ). While the non-reacting subscale of mindfulness did not reach statistical significance ( $P = .08$ ), all other metrics reflected robust improvements in mental health awareness, resilience, and help-seeking intent. Parallel monitoring and feasibility assessments revealed high usability scores, user satisfaction, and perceived usefulness. Ethical considerations, particularly data privacy, informed consent, algorithmic transparency, and escalation to human oversight, were central to the intervention's development and deployment. The project's implementation affirmed the potential of ethically grounded digital tools to support youth mental health in resource-constrained environments. To conclude, *AkiliBora* demonstrates a scalable, cost-effective, and ethically sound approach to addressing youth mental health challenges in university settings. Its integration of evidence-based assessments, AI-driven interaction, and real-time healthcare linkage offers a replicable model for digital mental health innovation in similar low-resource contexts. As a next step, national and institutional integration, coupled with policy alignment and continuous ethical review, is recommended to ensure long-term sustainability and impact.

**Keywords:** Digital mental health, Chatbot, Suicide prevention, Youth, Ethical AI, University students

## AI-powered health diagnostic tool: Utilizing artificial intelligence in a sustainable health system for managing malaria

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**Background and Significance:** Malaria remains one of the most pressing public health challenges in sub-Saharan Africa, accounting for over 95% of global cases. Despite ongoing interventions, there remains a significant gap in early detection, prompt treatment, and robust surveillance, especially in resource-limited settings. Recognizing the transformative potential of Artificial Intelligence (AI) in healthcare, this project investigates how AI-powered diagnostic tools can bridge this gap, improving malaria detection accuracy and ultimately contributing to Ghana's broader socioeconomic development. The research aligns with national health goals and global calls for innovative, cost-effective solutions to manage malaria sustainably.

**Methodology:** The project adopts a mixed-methods approach, combining both qualitative and quantitative techniques. Data collection involves field observations, focus group discussions, informant interviews, desk reviews, and structured surveys across selected districts in Ghana. Multi-stage sampling ensures representation from key stakeholders, including public health institutions, community health centers, and government agencies. The AI diagnostic tool will be developed, pre-tested, and refined through iterative feedback loops. Data will be analyzed using statistical methods alongside content and thematic analysis to uncover trends, barriers, and enablers of AI integration into existing health systems.

**Key Findings/Preliminary Results:** Initial reviews and stakeholder engagements indicate that integrating AI tools for malaria diagnosis can significantly enhance the speed and accuracy of detection, particularly in rural communities where laboratory resources are scarce. Early feedback also suggests strong interest among healthcare providers in leveraging AI for predictive analytics to identify outbreak hotspots. However, challenges such as infrastructure gaps, limited technical expertise, and data privacy concerns have been identified as potential obstacles.

Preliminary policy insights emphasize the need for capacity building, ethical AI frameworks, and community engagement to ensure widespread adoption and trust.

**Conclusion and Implications:** This project demonstrates the critical role AI-powered diagnostic tools can play in addressing malaria in Ghana. By improving diagnostic accuracy and enabling predictive surveillance, these tools can support timely treatment, reduce transmission, and enhance the resilience of health systems. Beyond health outcomes, the study highlights how AI can stimulate employment, innovation, and economic growth within the technology and health sectors. The evidence-based recommendations emerging from this research will inform policymakers, development partners, and stakeholders on best practices for scaling AI health interventions sustainably, ensuring that vulnerable communities benefit equitably from technological advancements.

**Keywords:** Artificial Intelligence, Malaria Diagnosis, Health Systems, Predictive Analytics, Ghana.

