TRANS-SAHARA

AFRICAN WEFE NEXUS SUMMIT

EVENT PROGRAMME &

Book of Abstracts

KNUST Campus, Kumasi, Ghana 14th July 2026

Funded by the European Union

Funded by the European Union under the Horizon Europe Framework Programme Grant Agreement Nº: 101182176. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or of the European Research Executive Agency. Neither the European Union nor the granting authority can be held responsible for them

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AFRICAN WEFE NEXUS SUMMIT: HARNESSING RESOURCES FOR SUSTAINABLE CLIMATE-SMART WATER-SECURE DEVELOPMENT

KNUST Campus, Kumasi, Ghana
13th-15th July 2026

unesco Centre for Engineering Education
Category II Centre under the auspices of UNESCO
TCC INTERNATIONAL CENTRE FOR INNOVATION, MANUFACTURING, TECHNOLOGY TRANSFER AND ENTREPRENEURSHIP, KNUST, KUMASI
TRANS-SAHARA Agro-Forestry Living Labs Demonstration
KNUST Kwame Nkrumah University of Science and Technology, Kumasi

EU Funding Acknowledgement

This Summit and the publication of this Book of Abstracts have been organised as part of the TRANS-SAHARA Project: *Novel WEFE Nexus-based approaches towards agroforestry management in the Greater North African Region*.

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No: 101182176 (Proposal: HORIZON-CL6-2024-FARM2FFORK-01-10).

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Design and Layout by: Francis K. N. Nunoo (PhD)

Published by: Department of Publishing Stuidies on behalf of the TRANS-SAHARA Project Consortium.

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Messages

Vice-Chancellor, KNUST

I am delighted to welcome you to the African WEFE Nexus Summit 2026, hosted by the Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana, under the auspices of the TRANS-SAHARA Project. On behalf of the University Council and Management, I extend warm greetings to our distinguished keynote speakers, researchers, policymakers, industry leaders, development partners, and participants from across Africa and beyond.

The theme of the summit, "Harnessing Resources for Sustainable Climate-Smart Water-Secure Development," reflects one of the defining challenges of our time. Across Africa, the interconnected issues of water security, energy access, sustainable food production, ecosystem restoration, and climate resilience demand integrated, innovative, and science-driven solutions. The Water-Energy-Food-Ecosystem (WEFE) Nexus provides a powerful framework for addressing these complex challenges while advancing sustainable development and improving livelihoods.

KNUST is honoured to serve as the African host institution for this important Summit through the Technology Consultancy Centre – a Centre for Innovation, Manufacturing and Emerging Technologies (TCC-CIMET). As one of Africa's leading

science and technology universities, KNUST remains steadfast in its commitment to excellence in teaching, research, innovation, and community engagement. Our participation in the European Union-funded TRANS-SAHARA Project demonstrates our dedication to fostering interdisciplinary collaboration and developing practical solutions that advance sustainable development across the continent.

I am encouraged by the Summit's emphasis on partnerships among academia, government, industry, development agencies, and local communities. I am confident that the discussions and networking will inspire new collaborations and impactful solutions for Africa and the global community.

I commend the TRANS-SAHARA consortium, our international and local partners, the organising committee, sponsors, reviewers, and all authors whose dedication has made this summit and Book of Abstracts possible. Your contributions demonstrate the transformative potential of international cooperation in advancing sustainable development.

As we deliberate on the future of climate-smart and water-secure development, let us reaffirm our collective commitment to translating research into practical solutions, empowering the next generation of innovators, and building resilient societies capable of meeting the environmental challenges of the twenty-first century.

I wish you a successful and intellectually rewarding summit; and I trust that your participation will lead to meaningful collaborations and a lasting impact.

Thank you, and ***Akwaaba*** to KNUST.

Prof. (Mrs.) Rita Akosua Dickson
Vice-Chancellor
Kwame Nkrumah University of Science and Technology (KNUST)
Kumasi, Ghana

Municipal Chief Executive of the Oforikrom Municipal Assembly

Greetings from the King, the Regional Minister, and the entire Asanteman. I warmly welcome every delegate who has travelled from different parts of Africa, and the world to participate in this important gathering.

I am delighted that the Kwame Nkrumah University of Science and Technology, one of Africa's leading centres of excellence in science, technology, and innovation has partnered the Technical University of Munich in hosting this summit with the support of the European Commission. KNUST has consistently demonstrated leadership in advancing research that responds to Africa's most pressing development challenges, making it an ideal venue for discussions on the Water-Energy-Food-Ecosystems Nexus.

Africa is on the frontline of climate change and issues like growing pressure on water resources, rising energy consumption, waste management, and food security challenges are evident. The need to ensure food security for instance, require innovative and integrated solutions because these concerns are not isolated but highly interconnected.

Water supports agriculture, industry, and households. Reliable energy enhances irrigation and processing of agro-products. Healthy ecosystems protect rivers, regulate the climate, and sustain biodiversity while sustainable food systems depend on the careful management of these resources. Therefore, the WEFE Nexus provides an essential framework for planning and governing communities and livelihoods in the twenty-first century.

Africa's potential is immense. The continent possesses abundant renewable energy resources, extensive agricultural opportunities, vibrant ecosystems, and a dynamic, youthful population ready to innovate. Bridging the gap between knowledge and action is urgent.

Ghana recognises that sustainable development hinges on integrated management of water, energy, food, and ecosystems. The nation is actively advancing initiatives that support sustainable water, energy, and environmental management. Yet, significant work remains. Tackling today's intricate environmental challenges demands robust collaboration among local governments, national institutions, universities, the private sector, development partners, and communities. This summit offers a unique platform to forge those essential partnerships.

The research findings, technological innovations, and policy recommendations from this summit must extend far beyond conference halls and academic journals. They must actively shape government policies, enhance local planning, guide investment decisions, and tangibly improve the daily lives of citizens.

I encourage participants to use this summit to build networks that extend beyond institutional and national borders. Climate change recognises no borders, and neither should our solutions.

Allow me to convey my heartfelt gratitude to the Organising Committee, Kwame Nkrumah University of Science and Technology, and all the supporting institutions, sponsors, and development partners, whose unwavering commitment has brought this summit to life.

Finally, Kumasi is honoured to host you all. Your time in our vibrant city will be both productive and memorable. Beyond the conference sessions, please seize the opportunity to immerse yourself in the rich cultural heritage, warm hospitality, and dynamic entrepreneurial spirit that define Kumasi's uniqueness.

Have a productive session!

Thank you very much.

Hon. Anwel Sadat Ahmed

Municipal Chief Executive (MCE)
Oforikrom Municipal Assembly, Kumasi

The Principal Investigator/Project Coordinator

It is my great pleasure to welcome you to the African WEFE Nexus Summit 2026. Bringing together researchers, policymakers, development partners, industry leaders, and practitioners from across Africa and beyond, this Summit marks an important step in advancing integrated solutions for sustainable development.

As a flagship initiative of the TRANS-SAHARA Project, funded by the European Union under the Horizon Europe Programme, the Summit reflects our shared commitment to addressing the interconnected challenges of water security, sustainable energy, food systems, ecosystem restoration, and climate resilience through the Water-Energy-Food-Ecosystem (WEFE) Nexus approach. These challenges require interdisciplinary collaboration, innovative thinking, and partnerships that extend across institutions, sectors, and national boundaries.

More than a forum for scientific exchange, this Summit provides an opportunity to showcase innovative solutions, strengthen partnerships, and foster dialogue that can inform policy, accelerate innovation, and promote sustainable development across Africa. The breadth of expertise represented here demonstrates the growing importance of the WEFE Nexus as a framework for building resilient communities and ecosystems.

I am particularly encouraged by the strong participation of early-career researchers and young professionals. Their creativity and commitment will play a vital role in shaping the future of WEFE Nexus research, innovation, and leadership on the continent.

My sincere appreciation goes to our consortium partners, the European Commission, the Kwame Nkrumah University of Science and Technology (KNUST), TCC-CIMET, the Scientific and Organising Committees, keynote speakers, sponsors, and all participants whose dedication has made this Summit possible.

I encourage you to engage actively, exchange ideas openly, build new collaborations, and identify practical pathways for implementing WEFE Nexus solutions. I am confident that the relationships established and the knowledge shared during this Summit will contribute to lasting scientific cooperation and sustainable impact across Africa.

Wishing all a productive, inspiring, and rewarding Summit!

Prof. Daphne Gondhalekar

Project Coordinator & Principal Investigator

TRANS-SAHARA Project

Technical University of Munich (TUM), Germany

The Director General TCC-CIMET

I am profoundly honoured to welcome you to the African WEFE Nexus Summit 2026. Your presence here reflects our shared commitment to addressing some of the most urgent and interconnected challenges facing Africa and the world.

On behalf of the Technology Consultancy Centre (TCC) and the entire organising committee, I sincerely thank every participant for accepting our invitation and contributing your expertise, experience and ideas to this important continental dialogue. This summit is more than an academic conference. It is a meeting of minds, a platform for innovation, and a call to collective action.

Across Africa, we continue to witness the growing impacts of climate change. Droughts, floods, declining soil fertility, water insecurity, biodiversity loss and rising energy demands are increasingly affecting livelihoods, food production and economic development. These challenges do not occur independently; they interact in complex ways that require integrated solutions.

The Water-Energy-Food-Ecosystems (WEFE) Nexus provides such a framework. It reminds us that sustainable development cannot be achieved through isolated sectoral interventions. Water security depends on healthy ecosystems. Food production depends on sustainable water management and reliable energy. Renewable energy development must protect biodiversity. Urban and rural development must be planned within ecological limits. Therefore, understanding these relationships is essential if Africa is to build resilient economies and sustainable communities.

The Technology Consultancy Centre has, for decades, served as a bridge between research, innovation and development practice. Our mandate has always extended beyond generating knowledge to ensuring that knowledge creates tangible improvements in people's lives.

Through this summit, we seek to strengthen that mission by bringing together researchers, policymakers, development practitioners, entrepreneurs, investors and community leaders to co-create practical solutions for sustainable resource management. Hence, the theme of this summit, "Harnessing Resources for Sustainable Climate-Smart Water-Secure Development," could not be more timely.

Over the next four days, you will engage in keynote lectures, technical sessions, panel discussions, poster presentations, exhibitions and networking events. I encourage you to make full use of these opportunities.

I wish to acknowledge our many partners, Scientific Committee, the Organising Committee, reviewers, volunteers and support staff whose dedication over many

months has culminated in this gathering. Your hard work has laid the foundation for what promises to be a truly impactful summit.

Thank you once again for choosing to be part of this important conversation.

May your time at KNUST be intellectually stimulating.

Medaase!

Prof. Francis K. Davis

Director General, Technology Consultancy Centre – Centre for Innovation, Manufacturing and Emerging Technologies (TCC-CIMET)

KNUST-Kumasi, Ghana

KNUST Team Lead

I am excited that the African WEFE Nexus Summit 2026, hosted by the Kwame Nkrumah University of Science and Technology (KNUST) under the TRANS-SAHARA Project.

Hosting this Summit reflects KNUST's commitment to advancing research, innovation, and partnerships that address Africa's pressing development challenges through integrated and sustainable solutions. Under the theme "Harnessing Resources for Sustainable Climate-Smart Water-Secure Development," the Summit provides a timely platform for bringing together researchers, policymakers, development partners, industry leaders, and practitioners to explore practical applications of the Water-Energy-Food-Ecosystem (WEFE) Nexus.

As the KNUST Team Lead for the TRANS-SAHARA Project, I am proud of the University's contribution to this international consortium and to creating opportunities for scientific exchange, capacity development, and collaborative innovation. The diversity of expertise represented at this Summit demonstrates the growing recognition that sustainable solutions emerge when knowledge is shared across disciplines, sectors, and national boundaries.

Beyond the technical discussions, I hope this Summit will strengthen partnerships that support research excellence, technology transfer, policy engagement, and the development of climate-smart solutions capable of improving livelihoods across Africa. It is also an opportunity to empower the next generation of researchers and innovators whose ideas will shape a more resilient and sustainable future.

I sincerely thank the European Union, the Technical University of Munich (TUM), our consortium partners, KNUST management, the Scientific and Organising Committees, keynote speakers, sponsors, volunteers, and every participant whose commitment has made this Summit possible.

I would like to encourage all to participate actively, engage in meaningful dialogue, and seize every opportunity to establish collaborations that will extend well beyond this event. Together, we can translate knowledge into action and create lasting impact for communities across Africa.

Thanks and best wishes!

Prof. Alexander Boakye Marful
KNUST Team Lead, TRANS-SAHARA Project
Technology Consultancy Centre – Centre for Innovation, Manufacturing and Emerging Technologies (TCC-CIMET)
KNUST-Kumasi, Ghana

Organising Committee Chair

On behalf of the Organising Committee, I heartily welcome all – delegates, researchers, policymakers, development partners, industry leaders, practitioners, and students – who have joined us for this landmark event.

The successful organisation of the African WEFE Nexus Summit reflects months of careful planning, collaboration, and commitment from numerous institutions and individuals. Our objective has been to create an inclusive platform that promotes scientific exchange, interdisciplinary dialogue, innovation, and strategic partnerships that address Africa's interconnected water, energy, food, and ecosystem challenges.

This Book of Abstracts showcases the outstanding scientific contributions selected for presentation during the summit. The diversity of research represented demonstrates the growing momentum of the WEFE Nexus approach as an effective framework for achieving climate resilience, environmental sustainability, resource efficiency, and inclusive socio-economic development across Africa.

We hope that every session, discussion, exhibition, and networking opportunity stimulates new ideas, strengthens existing collaborations, and inspires innovative solutions to address the complex challenges facing our continent. Beyond knowledge exchange, we encourage participants to build lasting partnerships that will endure long after the summit concludes.

I sincerely thank all authors, reviewers, session chairs, sponsors, partners, volunteers, and members of the Organising Committee, whose dedication and hard work have made this Summit possible. Your contributions have been invaluable to the success of this event.

I wish you a rewarding and inspiring summit and look forward to the lasting partnerships and transformative outcomes that will emerge from our collective engagement.

Prof. Ing. Sampson Oduro-Kwarteng

Chair, Organising Committee

African WEFE Nexus Summit 2026

Profile of Keynote Speakers

Ing. Dr. Deborah Darko

Ing. Dr Deborah Darko is a Senior Research Scientist at Ghana's CSIR-Water Research Institute, specialising in hydrology and climate change. She holds a PhD and BSc in Civil Engineering from Kwame Nkrumah University of Science and Technology, and an MSc in Environmental Resources Engineering from SUNY-ESF/Syracuse. With over 15 years' West African experience, her research focuses on hydroclimatology, flood and drought risks, and the water-energy-food-ecosystem nexus. She has led major Sida (EnsureWEF) projects and played key roles in UKRI GCRF (FutureDAMS) and DANIDA-funded projects. An external examiner and peer reviewer, she advances climate-smart, water-secure solutions across Africa.

Prof. Hanson Nyantakyi-Frimpong

Dr Hanson Nyantakyi-Frimpong is an Associate Professor in the Department of Geography and the Environment at the University of Denver. A political ecologist, his research explores the human dimensions of global environmental change, sustainable agriculture and food systems. Author of over 60 publications, he received the 2021 Distinguished Scholar Award from the American Association of Geographers' Africa Specialty Group for his participatory human-environment research. A Contributing Author to the IPCC Sixth Assessment Report, he is currently the Editor for the *Gender, Place and Culture* journal. He holds a PhD from the University of Western Ontario, Canada.

Dr. Martin Oulu

Dr Martin Oulu, an interdisciplinary scholar and agri-food systems expert, researches agroecology, climate change, and ecologically unequal exchange at the science-policy-practice interface. The 2025 Glidden Visiting Professor at Ohio University, he serves on the Advisory Council of the Food, Agriculture, Biodiversity, Land-Use, and Energy (FABLE) Consortium. An Agroecology Champion with the Forum for Agriculture Research in Africa (FARA), he founded the Intersectoral Forum on Agrobiodiversity and Agroecology (ISFAA), a multistakeholder platform initiating Kenya's National Agroecology Strategy. He is an Associate Lecturer at the University of Nairobi, co-leads CGIAR projects, and a member of the African food systems initiatives.

Prof. Hirotaka Matsuda

Professor Hirotaka Matsuda is Professor of Agricultural Innovation for Sustainable Society within the Faculty of Agriculture at Tokyo University of Agriculture (since 2022), having previously served as Associate Professor in the same department (2018–2022). He holds Master's and Doctoral degrees in Agriculture from Hokkaido University. Matsuda is affiliated with the University of Tokyo's Integrated Research System for Sustainability Science (IR3S), Graduate Program in Sustainability Science (GPSS) and Sustainability Science Global Leadership Initiative (GLI) at the Graduate School of Frontier Sciences. His research focuses on advancing sustainability science and agricultural innovation.

Prof. Yuji Hara

Professor Yuji Hara is Professor at Wakayama University's Faculty of Systems Engineering, Japan. With a geography background, he holds a Master's in Landscape Planning and a Doctor of Agriculture in Landscape Ecology (2007) from the University of Tokyo. Specialising in landscape planning and anthropogenic geomorphology, he conducts fieldwork across Japan, Thailand, the Philippines, the Netherlands and New York. His research evaluates Asian rice-based urban-rural landscapes and ecosystem services using indicator species, including mammals, frogs, dragonflies, the Japanese pond turtle and the Asian openbill stork. He is actively involved in the FAO's Globally Important Agricultural Heritage Systems.

Prof. Francis Davis

Prof. Francis Davis, a Mechanical Engineering Professor at KNUST and Director-General of the Technology Consultancy Centre, leads Africa's first UNESCO Category II Centre of Excellence in Engineering and Manufacturing. With over 20 years of experience in automotive engineering research and industry-academia partnerships, he champions KNUST's vision to position Akwaaba Magazine as West Africa's premier hub for Electric Vehicle innovation and e-mobility. His expertise covers sustainable manufacturing, EV diagnostics, battery systems, and sustainable transport, supported by collaborations with GIZ, Mastercard Foundation, DAA, COVET, and German universities via DAAD. Actively involved on-site, he develops infrastructure and training tools for artisan auto diagnostics.

Profile of Project Advisory Board Members

Tony Rinaudo

Tony Rinaudo is the Principal Natural Resources Advisor, World Vision Australia. He has spent more than four decades reshaping how the world thinks about land, farming, and regeneration. As an agriculturalist and missionary in Niger from 1981 to 1999, he helped drive a quiet revolution in farming practices—contributing to the re-greening of over six million hectares of land and influencing restoration movements worldwide. For his service to people and planet, the Nigerien government awarded him its highest honour for an expatriate. Since joining World Vision Australia in 1999, Tony has led land regeneration initiatives across the globe and now serves as Principal Climate Action Advisor. He is internationally recognised for championing Farmer-Managed Natural Regeneration (FMNR), a low-cost, scalable approach to reforestation that has transformed degraded landscapes. His work has been recognised with the Right Livelihood Award, the Luxembourg Peace Prize, and appointment as a Member of the Order of Australia.

Akiça Bahri

Akiça Bahri, a Tunisian agricultural engineer, is a distinguished expert in water resources management and marginal water utilisation. Formerly Tunisia's Minister of Agriculture, Water Resources and Fisheries, she served as Director for Africa at the International Water Management Institute (2005–2010) and Coordinator of the African Water Facility at the African Development Bank (2010–2015). She was a Professor at the National Agricultural Institute of Tunisia, and Researcher and Director of Research at INRGREF (2016–2020). Her research centres on water quality, efficiency, and environmental impacts of marginal waters and sewage sludge. A prolific author on integrated water resources management, her honours include the Kuwait Prize for Waste Recycling, the IWA Women in Water Award, and the Prof. C.N.R. Rao Prize.

Yuji Hara

Professor Yuji Hara is Professor at Wakayama University's Faculty of Systems Engineering, Japan. With a geography background, he holds a Master's in Landscape Planning and a Doctor of Agriculture in Landscape Ecology (2007) from the University of Tokyo. Specialising in landscape planning and anthropogenic geomorphology, he conducts fieldwork across Japan, Thailand, the Philippines, the Netherlands and New York. His research evaluates Asian rice-based urban-rural landscapes and ecosystem services using indicator species, including mammals, frogs, dragonflies, the Japanese pond turtle and the Asian openbill stork. He is actively involved in the FAO's Globally Important Agricultural Heritage Systems.

Hirotaka Matsuda

Hirotaka Matsuda is Professor in the Department of Agricultural Innovation for Sustainable Society, Faculty of Agriculture, Tokyo University of Agriculture (since 2022), having previously served as Associate Professor (2018–2022). He earned his Master's and Doctorate in Agriculture from Hokkaido University. Matsuda is affiliated with the Integrated Research System for Sustainability Science (IR3S), Graduate Program in Sustainability Science (GPSS), and Sustainability Science Global Leadership Initiative (GLI) at the Graduate School of Frontier Sciences, The University of Tokyo. His work focuses on advancing sustainability science and agricultural innovation.

Melanie Schulte

Melanie Schulte is the Team Coordinator of the Scientific Coordination Office Bavaria–Africa at the Bavarian Research Alliance (BayFOR). She holds both a Bachelor of Science in Forest Science and Resource Management and a Master of Science in Forest and Wood Science from the Technical University of Munich. Her work focuses on fostering international research collaboration and strengthening scientific partnerships between Bavaria and African institutions.

Ibrahim Boubacar

Dr Boubacar Ibrahim is an Associate Professor Ing Hydroclimatologist at Université Abdou Moumouni, serving as a Research Lecturer since 2016. He holds a PhD in Hydrology and Water Resources Science from Université Pierre et Marie Curie (Paris VI). His research spans water resources, supply and sanitation, climate change, and adaptation strategies. Specifically, he investigates urban flooding in West African cities like Niamey, hydrological modelling in the Nakanbé Basin, and groundwater quality. Dr Ibrahim's work evaluates the hydrological impacts of climate change, providing critical insights for sustainable water management and regional development across the Sudano-Sahel.

Emmanuel Cheo

Ambe Emmanuel Cheo holds a Ph.D. in Environmental and Resource Management, with over five years' experience in water resources, food security, and climate change. His doctoral research estimated water balance under the EU Water Framework Directive and evaluated management challenges to inform policy, building on earlier work engaging stakeholders on climate impacts. At UNU-ViE, he drives research and capacity building across Africa. He coordinates the Agrophotovoltaic for Mali and The Gambia (APV-MaGa) project, establishing sustainable energy systems delivering food, water, and electricity while enhancing agricultural resilience. Additionally, he serves on the UNFCCC Consultative Group of Experts (CGE) for non-Annex I Parties, conducting technical analysis of biennial update reports.

Organising Committee Membership

Prof. Sampson Oduro-Kwarteng
Chairperson

Prof. Jacob K. Agbenorhevi
Member/ Scientific Committee
Chairperson

Dr. Joan A. Serwaa Ameyaw
Member/ Scientific Committee

Dr. Daniel Kwegyir
Member/ Scientific Committee

Dr. Mrs Akosua Baah Kwarteng Amaka-Otchere,
Coordinator/Logistics

Dr. James Seutra Kaba
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Member/Administration

Mrs. Irene E. Otuba Nunoo
Member/Rapporteur

Dr. Francis K. N. Nunoo
Member/Layout Designer

Isaac Egyir. Kwofie
Member/Exhibitions

Project Background

Development context and Challenges

The Greater Northern African Region (GNAR), encompassing Northern Africa, the Sub-Saharan Sahel region and reaching east to Djibouti, Ethiopia and Somalia, is home to some of the world's poorest and politically unstable countries that are severely vulnerable to climate change impacts. This region represents nine biodiversity hotspots across Africa and is considered one of the driest in the world, with degraded land, that is most prone to climate-change-induced drought. This region is faced with agroforestry management problems with root causes such as: (1) A lack of data accessibility/ limited data to benchmark and understand the climatic, socio-economic and agricultural situation across GNAR, including agroforestry's potential to contribute to climate change adaptation and mitigation. Data limitations are driven largely by a lack of infrastructure for collection; (2) limited agroforestry management interventions due to severe water shortages; and (3) limited capacities of stakeholders to understand and evaluate the socio-economic and environmental performance potential of agroforestry in a politically volatile and environmentally degraded region. Furthermore, end-users across GNAR (in particular farmers and land owners) have limited incentives to take up and implement agroforestry in a sustainable manner, due to challenges in framework conditions such as regulatory issues, land disputes, and a lack of functioning business models. The needs for data production, capacity development and the integration of socio-economic values such as capacity, equality and justice, are not fully understood or leveraged to make sustainable agroforestry possible. There is also the a of lack of incentives and thriving innovation ecosystems in agroforestry management to foster higher adaptability among end-users in the GNAR and replicability across the African Union.

Project Aim

The TRANS-SAHARA project seeks to advance beyond the state-of-the-art by addressing the agroforestry implementation problems in the GNAR: (i) data gaps, (ii) lack of GNAR-specific scalable agroforestry interventions, (iii) the need for strengthened capacities to evaluate socio-economic aspects in a politically volatile region, and (iv) limited end-user incentives to take up agroforestry measures. The TRANS-SAHARA project is addressing these challenges by using water security as an entry point to focus on agro-silvo-pastoral systems in the GNAR. Its overarching aim is to (i) increase the water content in regional water cycles to facilitate the regeneration of degraded ecosystems, (ii) develop of bespoke, data-driven, scalable and economically viable agroforestry interventions in three living labs (Tunisia, Ghana, Ethiopia) to showcase agroforestry innovations, and finally (iii) facilitate an innovation ecosystem at regional, national and global scales by embedding its approach from the outset in a participatory multi- stakeholder socio-economic process to support a systemic socio-technical transition.

Project work packages

The project is focused on a novel nexus-based approach towards agroforestry management in the Greater Northern African Region, and has the following work packages:

WP1 Project management highlights,

WP2 Multi-stakeholder engagement,

WP3 Strategies for data identification, collection and sensing and database development,

WP4 Development of TRANS-SAHARA Models and the Agroforestry Intervention Design Tool

WP5 Socio-economic innovations,

WP6 Agroforestry Nexus Living Labs Demonstration,

WP7 Capacity building programme development,

WP8 Documentation and communications,

Project Partners

There are 15 implementing partners and six associate partners:

Implementing partners

1. Technische Universitaet Muenchen (**TUM**), Germany
2. Zabala Brussels (**ZABALA**), Belgium
3. Accademia Europea di Bolzano (**EURAC**), Italy
4. Kwame Nkrumah University of Science and Technology (**KNUST**), Kumasi, Ghana
5. West African Science Services Centre on Climate Change and Adapted Land Use (**WASCAL**), Ghana
6. Universite Panafricaine Institut des Sciences de l'eau et de L'energie (**PAUWES**), Algeria
7. Universite Cheikh Anta Diop de Dakar (**UCAD**), Senegal
8. Institut Polytechnique Rural de Formation et de Recherche Appliquee (**IPR/IFRA**), Mali
9. International Centre for Research in Agroforestry (**ICRAF**), Kenya
10. Institut National de Recherches en Genie Rural, eaux et Forets (**INRGREF**), Tunisia
11. Agence Senegalaise de la Reforestation et de la grande Muraille Verte (**GGW-SENEGAL**), Senegal
12. Agence National de la Grande Muraille Verte **(GGW-CHAD**), Chad
13. Universite de Tunis El Manar (**UEM**), Tunisia
14. Environment Europe Foundation Stichting (**EEF**), Netherlands
15. Ministere de L'environnement et du Developpement Durable (**GGW-DJIBOUTI**), Djibouti

Associate partners:

16. National University Corporation Wakayama University (**UWAKA**)
17. National University Corporation Tottori University (**UTOTO**)
18. Tokyo University of Agriculture (**UTOKYO-AGR**)
19. United Nations University (**UNU-EHS**)
20. Bayerisches Staatsministerium fur Umwelt und Verbraucherschutz (**StMUV**)
21. Secretariat of the United Nations Convention to Combat Desertification (**UNCCD**)

Programme schedule

Background to the Summit

The African WEFE Nexus Summit is part of and implemented under the TRANS-SAHARA project. Coordinated by Technische Universität München (TUM) and funded by the European Union under the Horizon Europe Framework Programme. The TRANS-SAHARA project aims to advance agroforestry management in the Greater Northern African Region through a Water-Energy-Food-Ecosystem (WEFE) Nexus-based approach.

As a key partner, the Kwame Nkrumah University of Science and Technology (KNUST), through TCC-CIMET, is hosting the African WEFE Nexus Summit. As a leading institution with demonstrated expertise in sustainable technologies, innovation ecosystems, and climate-smart development, the TCC-CIMET, is uniquely positioned to anchor this high-impact continental dialogue. The TRANS-SAHARA Project Coordination Office is working closely with the TCC-CIMET team to co-host the summit, mobilise international partners, coordinate logistics, and secure additional support from sponsoring bodies.

Summit Aim: The Summit aims to bring together key stakeholders from academia, government, development agencies, private-sector actors, and community organisations to advance integrated Water-Energy-Food-Environment (WEFE) Nexus solutions across Africa.

The Specific objectives of the Summit are**:**

1. **Sharing knowledge, best practices and lessons learned on climate-smart water solutions** through facilitating interdisciplinary knowledge exchange on WEFE Nexus innovations; and discussing challenges and opportunities for improvement.
2. **Showcasing African-led climate-smart water technology and WEFE research outputs,** frugal innovations, and circular-economy practices through exhibitions, posters and presentations,
3. **Strengthening institutional partnerships for climate-smart water resilience and water security** through dialoguing with development partners, governments and industry players to support sustainability Strategies and model WEFE infrastructure development for training the next generation of skilled workers and farmers for sustainable development.
4. **Creating WEFE Nexus impact hub platform for stimulating climate-smart water innovations** through student and researcher mobility, South–South cooperation, and WEFE capacity building,
5. **Communicating actionable WEFE nexus policy recommendations** on climate-smart water innovations for national and regional adoption.

Event Format: Presentations by speakers, panelists, researchers at plenary, parallel and posters sessions. In total, about 150 participants are expected to attend the African WEFE Nexus Summit, including representatives from the TRANS-SAHARA project partners, ministries, universities and the general public. The key components of the Summit are:

- TRANS-SAHARA Project achievement presentations,

- Four (4) plenary presentations on WEFE Nexus focusing on Africa,
- African WEFE panel discussions,
- WEFE scientific knowledge-sharing in three (3) breakout parallel sessions,
- WEFE Projects results and exhibitions showcase,

Keynotes presentations on summit theme: The plenary presentations and panel discussion sessions of the event involves a hybrid format (face-to-face and online) to provide access to remote participants via livestreaming of the plenary sessions (links will be provided on the KNUST TEK TV Youtube Channel and Trans-Sahara website and social media). The four plenary presentations on WEFE Nexus are:

- "Climate Change Impacts on Water, Energy, Food, and Ecosystems in the Trans-Sahara Region"
- "Household Food Security, Nutrition, and the Natural Environment: Emerging Perspectives from Sub-Saharan Africa through the WEFE Nexus"
- "Productivity assessment and effective monitoring for rice fields: a case study in Surin Province, Thailand"
- "Policy, Institutional Frameworks and Sustainable Finance of WEFE Nexus projects in Africa: Lessons learned and best practices in implementing WEFE Nexus approaches"

Scientific session presentations: There are 18 oral presentations and over 34 poster presentations and exhibitions sessions. There are three Parallel Sessions (6 papers per session) grouped under the following WEFE Nexus Thematic Areas:

- **Water W:** Smart water management and wastewater reuse in WEFE nexus, ***(4 papers)***
- **Energy E:** Smart energy systems in WEFE nexus, ***(2 papers)***
- **Food F:** Sustainable food systems, ***(6 papers)***
- **Ecosystem E:** Agroforestry for ecosystem restoration and Climate resilience in arid and semi-arid regions, ***(6 papers)***

Three Parallel Sessions (6 papers per session) are grouped under the following themes:

Session I (6 papers)	Session II (6 papers)	Session III (6 papers)
• **Water:** Smart water management and wastewater reuse in WEFE nexus ***(4 papers)*** • **Energy:** Smart energy systems in WEFE nexus, ***(2 papers)***	• **Food:** Sustainable food systems, ***(6 papers)***	• **Ecosystem:** Agroforestry for ecosystem restoration and Climate resilience in arid and semi-arid regions, ***(6 papers)***

Moreover, there will be a poster and exhibitions sessions (over 34 poster presentations).

Summit Programme schedule

Tuesday, 14th July - African WEFE Nexus Summit	
Project Partners + Advisory Board members + External experts and stakeholders invited	
8:30 –9:00	Arrival of participants and registration **Facilitator**: Protocol Officers
9:00 –10:30	Opening of the Summit: • Dance Performance (10 minutes) • African: WEFE Summit formal Launch: by KNUST Vice Chancellor (5 minutes) Welcome address and opening remarks: • Welcome address by TCC-CIMET Director (10 minutes) • Welcome address by VC/Representative (Pro-VC) (10 minutes) • Opening remarks by Trans-Sahara Project, KNUST lead -Prof. Alex Marful (20 minutes) • Overview of TRANS-SAHARA Project, by Project Coordinator, PI Prof. Daphne Gondhalekar (25 minutes) Cultural performance (10 minutes) **Moderator**: Dr Joana Akua Serwaa Ameyaw
10:30 –11:00	**Group Photograph/Tea/Coffee Break**
11:00 –12:00	**Plenary Session I**: Addressing Climate Challenges through the Water-Energy-Food-Ecosystems Nexus • **Keynote Presentation 1:** "Climate Change Impacts on Water, Energy, Food, and Ecosystems in the Trans-Sahara Region": o Water and Energy by **Ing. Dr Deborah Darko**, a Research Scientist at Water Research Institute of the Council for Scientific and Industrial Research, Ghana. (15 minutes); o Food and Ecosystems by Prof. Hanson Nyantakyi Frimpong, an Associate Professor at the University of Denver, USA. (15 minutes). • **Keynote Presentation 2** "Household Food Security, Nutrition, and the Natural Environment: Emerging Perspectives from Sub-Saharan Africa through the WEFE Nexus" - **Prof. Hirotaka Matsuda**, Tokyo Agricultural University, Japan. (15 minutes).

<table>
<tr><td>11:00 –12:00</td><td>• Keynote Presentation 3 “Productivity assessment and effective monitoring for rice fields: a case study in Surin Province, Thailand” Prof. Yuji Hara, Wakayama University, Japan. (15 minutes).

Moderator: Dr Joana Akua Serwaa Ameyaw</td></tr>
<tr><td>12:00- 13:00</td><td>Panel Discussion “Agro-forestry Living Labs as a Platform for WEFE Nexus Implementation, overview of the Agro-forestry Living Labs in the Trans-Sahara region and possibilities for the scaling up in Africa”.

Panelists:
Dr. Boubacar Ibrahim, Abdou Moumouni University (UAM) (Niger)
Dr. Martin Oulu, Visiting Professor at Ohio University, USA.(Online)
Prof. Akiça Bahri, Former Minister and Professor of National Agricultural Institute of Tunisia
Mr. Tony Rinaudo, World Vision (Australia)
Mr. Emmanuel Cheo, United Nations University - Institute for Environment and Human Security (UNU-EHS)
Prof. Yuji Hara, Wakayama University (Japan)
Prof. Hirotaka Matsuda, Tokyo Agricultural University (Japan)

Moderators: Prof. Daphne Gondhalekar, TUM, TRANS-SAHARA Project Coordinator, & Prof Daniel Addai Yaw Duah, KNUST</td></tr>
<tr><td>13:00 –14:20</td><td>Lunch Break</td></tr>
<tr><td>14:20– 15:00</td><td>Walk through Poster Presentations and Exhibition booths for TRANS-SAHARA Project partners and stakeholders</td></tr>
<tr><td>15:00 –16:30</td><td>Parallel Sessions I, II & III: Presentations of Papers (18)

<table>
<tr><th>Session I</th><th>Session II</th><th>Session III</th></tr>
<tr><td>Chair: Prof. Oduro-Kwarteng
Co-chair: Dr. Daniel Kwegyir
Rapporteur: Irene Esi Nunooi

• Water: Smart water management and wastewater reuse in WEFE nexus
• Energy: Smart energy systems in WEFE nexus</td><td>Chair: Prof. Jacob Kwaku Agbenorhevi
Rapporteur: Abigail Ackon

• Food: Sustainable food systems</td><td>Chair: Dr. Joana Akua Serwaa Ameyaw
Rapporteurs: Stephanie Davis & Jacintha Mandy Baah

• Ecosystem: Agroforestry for ecosystem restoration and Climate resilience in arid and semi-arid regions</td></tr>
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16:30 –16:45	**Tea/Coffee Break**
16:45 –17:15	**Plenary Session II:** Policy, Institutional Frameworks and Sustainable Finance of WEFE Nexus projects in Africa **Keynote Presentation 4**: Lessons learned and best practices in implementing WEFE Nexus approaches **– Dr. Martin Oulu, Ing. Dr. Deborah Darko and Prof. Hanson Nyantakyi Frimpong** (30 minutes) **Moderator**: Prof Jacob Kwaku Agbenorhevi
17:15 –17:30	Launch of the Africa WEFE Nexus Impact Hub: **Prof. Alex Boakye Marful** • Introduction to the hub's objectives and activities • Launch ceremony **Moderator**: Dr Joana Akua Serwaa Ameyaw
17:30–18:30	African WEFE Summit Closing Remarks • Reflection and Reporting back from Parallel Sessions, • Presentation of Awards • Closing remarks • Vote of thanks **Moderator**: Dr Joana Akua Serwaa Ameyaw
18:30	**Official closing/End of Summit**

Exhibition

Ghana Living Lab Exhibition

Summary: The Ghana Living Lab exhibition communicates three key messages. First, the Living Lab landscape faces real challenges, including rocky soils, water scarcity, land degradation, limited processing capacity, and climate stress. Second, the area also has valuable local resources, including agroforestry products, indigenous knowledge systems, sacred groves, wells, and community-based conservation practices. Third, by combining local knowledge with appropriate technologies, value addition, renewable energy, and water-efficient systems, the Ghana Living Lab can demonstrate practical pathways for climate-smart, livelihood-enhancing, and ecosystem-sensitive development.

Background: The Ghana Living Lab exhibition presents the Living Lab as a practical demonstration of the Water–Energy–Food–Ecosystem (WEFE) Nexus in action. The exhibition showcases the environmental context, livelihood opportunities, local resource-use systems, and proposed innovations for building climate-resilient agroforestry landscapes in Northern Ghana. It is designed to help summit participants understand the realities of the Living Lab area, the challenges faced by communities, and the integrated solutions being promoted under the TRANS-SAHARA Project.

Background photographs: The exhibition has a strong visual storytelling component. Background photographs display a drone view of the Living Lab landscape, highlighting the rocky nature of the land, land degradation challenges, existing water conservation structures such as stone contours, and the different types of wells found in the area. The display also show sacred groves as important spaces for ecosystem conservation, existing agroforestry practices, fuelwood use in traditional medicine preparation, local food processing activities, and other livelihood practices. These visuals provide visitors with a clear sense of place and help explain why integrated water, energy, food, and ecosystem interventions are needed.

Value-chain display: A major feature of the exhibition is a value-chain display showing how locally available agroforestry and food products that can be transformed into higher-value market products. These include the shea value chain from shea nuts to shea butter, presented in different packaging options ranging from local to improved market-ready forms. Groundnut products are displayed, showing progression from raw groundnuts to processed groundnut paste or butter. Leafy vegetables are presented in fresh, dried, and vacuum-packaged forms to demonstrate possibilities for reducing post-harvest losses and improving shelf life. Fruits from trees within the Living Lab, such as shea fruit, baobab, dawadawa, mango, and tamarind (depending on what is in season now), are showcased to highlight the livelihood potential of tree-based systems.

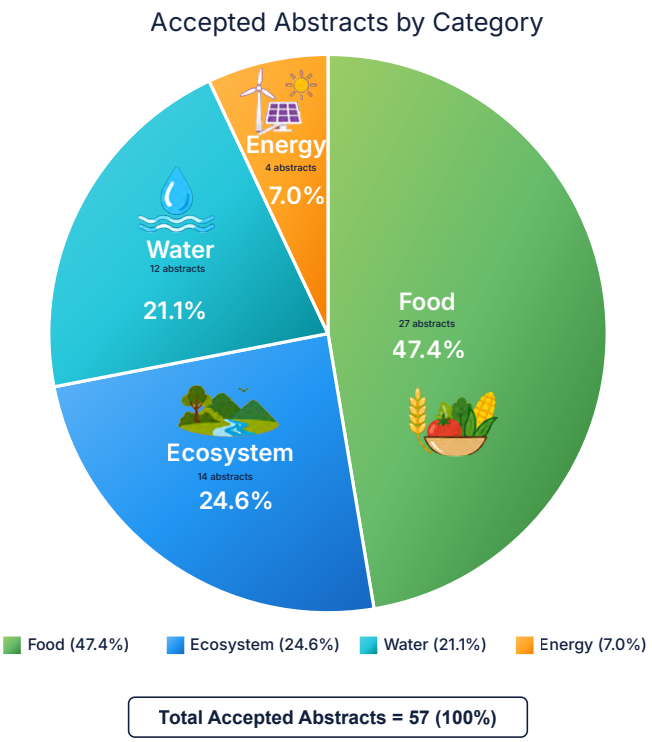
Technology and innovation corner: The exhibition also include a technology and innovation corner to showcase solar powered drip irrigation system and water management.

Electronic screen show: An electronic screen shows videos or slides of food processing machines and the steps involved in cleaning, drying, milling, grinding, pressing, packaging, and storage. This demonstrates how appropriate technologies can improve processing efficiency, product quality, and income opportunities, especially for women and youth engaged in local value chains.

Aquaponics and solar-powered drip irrigation systems*:* Two live demonstration systems are showcased at the exhibition. The first is a small aquaponics system where wastewater from fish production is used to irrigate green leafy vegetables. This illustrates efficient water reuse, nutrient recycling, and integrated food production. The second is a solar-powered drip irrigation system, demonstrating how renewable energy can support efficient water use for crops and tree seedlings in water-stressed environments. Together, these systems provide practical examples of how the WEFE Nexus can be operationalised at community level.

Statistics of Abstracts

Category	Oral	Poster	Total
Water	4	8	12
Energy	2	2	4
Food	6	21	27
Ecosystem	6	8	14
Total	**18**	**39**	**57**



Total Accepted Abstracts = 57 (100%)

Parallel Session Presentations:

- 10 min for the oral presentation, followed by 5 min for questions/comments.
- Thus, 15 min x 6 = 1 h 30 min for oral presentations.

Abstracts by Category and Presentation Type

Oral Abstracts by Category

Water

4

1. Nature-based water treatment as an essential part of the WEFE Nexus at the Water Hub living lab
2. Biochar as a sustainable filter media in nature-based solutions for water reuse in the WEFE Nexus context
3. Performance of a drip irrigation system for tomato production in Timéré (Niger) with solar energy
4. Managed Aquifer Recharge for local WEFE Nexus resource security: Insights from a living lab in Niger

Energy

2

1. Nothing left to steal:The attenuation paradox and the educational toll of the water-energy nexus in Ghana
2. Temperature effects on cocoa husk biochar and bio-oil composition using an improved traditional kiln

Food

6

1. Antibiotic use and antimicrobial resistance in ruminant livestock in Africa: A systematic review
2. Comparative characterisation of the physicochemical and functional properties of three date fruit varieties marketed in Tamale, Ghana
3. Optimising seedling age for climate-smart water productivity in upland rice
4. Quality and safety of minced meat: A systematic review of adulteration and its public health implication
5. Effect of formulated organic fertiliser and inorganic fertiliser on cucumber growth and yield in ferric acrisols
6. Composting dynamics and quality characterisation of cocoa husk biochar–based organic fertiliser

Ecosystem

6

1. Economic Analysis of agroforestry systems in Tunisia
2. A multi-objective optimisation model of land use allocation for the Greater Northern African Region
3. From arid land to oasis: Evidence from a long-term WEFE Nexus practice in Southern Madagascar
4. Stakeholder-Informed Design of the NEXSOL WEFE Nexus tool for climate-resilient agroforestry planning
5. Forging a new user-friendly data-efficient WEFE Nexus Model in TRANS-SAHARA
6. The first step to a giant leap: A pilot experience of the potential industrial symbiosis network in Ghana

Poster Abstracts by Category

Water

8

1. Water-Energy-Food nexus governance in the Caribbean (Barbados and Jamaica) for climate justice
2. Water use, livelihoods, and sustainability: analysing blue water footprints in smallholder vegetable production in northern Ghana
3. Adsorption of tetracycline and metronidazole residues from landfill leachate using biochar from shea nut shell
4. Comparative hydrological assessment of conditionally merged rainfall data and satellite-based rainfall products in a data-scarce tropical basin
5. Adsorptive removal of iron and manganese using optimised activated carbon
6. Enabling the scale-up of treated wastewater reuse in Accra, Ghana: A policy mix analysis
7. Seasonal variation in physicochemical parameters and heavy metal contamination in rivers within the Abuakwa South Municipality of Ghana
8. Explainable machine learning for flood risk classification across all 16 administrative regions of Ghana using GloFAS discharge and CHIRPS rainfall data (2000–2025)

Energy

2

1. Modelling porosity dynamics in sand microbial fuel cells: A systematic review
2. Type-II van der Waals heterostructures of SiC/Al2OS monolayers for photocatalysis and optoelectronics applications

Food

21

1. Sustainable food crop systems in northern Ghana: A scoping literature review
2. Catalytic upcycling of cocoa pod husk lignin to aromatic monomers
3. Collaboration in farmer research networks (FRNS) supporting soil health innovation in Malawi
4. The paradox of Pelt Value-Chain; short-term food security against long-term industrial economic growth in Ghana
5. Prospects for an indigenous knowledge–driven mechanised cassava production and bio-economy in Africa
6. Identifying critical attributes for maize raintree porridge development: a choice-based conjoint analysis approach
7. Harnessing underutilised indigenous starch resources for sustainable biodegradable film development: A circular bioeconomy approach to reducing plastic pollution in food and water ecosystems
8. Indigestible foreign material ingestion in Ghanaian goats: a multi-stakeholder WEFE Nexus assessment
9. Utilisation of de-starched cassava in fish feed development
10. Optimisation of nixtamalisation effects on the techno-functional properties of rice and fonio flours with implications for gluten-free bread development
11. Optimised nixtamalisation conditions of millet and sorghum for Industrial Processing of quality gluten-free bread flour
12. Nutrigenomic potential of bambara groundnut (vigna subterranea) in modulating gene–diet interactions associated with type 2 diabetes
13. Evaluation of okra pectin as an alternative emulsifier in milk chocolate: Effects on rheological, textural, and sensory properties
14. Strengthening participatory approaches for expanding and deepening learning about farmer preferences: Insights from farmer-managed seed systems in Malawi
15. Human health risk assessment of heavy metals in Colocasia esculenta (L.) cultivated in the Suame light industrial and municipal areas, Kumasi, Ghana
16. Mechanisation and gender issues in tiger nut production systems in the Kwahu East District of Ghana

17. Targeting bakery products for dysphagia, sarcopenia and protein malnutrition management in older adults: A systematic review
18. Predicting aflatoxin contamination in white and yellow maize using Vis/NIR spectroscopy combined with PCA-LDA and PLSR models through aquaphotomics approaches
19. Valorisation of okra for multifunctional industrial applications
20. Physicochemical, phytochemical and sensory evaluation of hibiscus-based tea bag formulation
21. From potential to productivity: a climate-resilient rice system for sustainable food security in the Odaho inland valley, Ghana

8

Ecosystem

1. Explaining sustainability in Ghana's public sector: The influence of politics and external pressures
2. Tracing toxic legacies: Profiling the presence of flame retardants at Asawasi and Dagomba line informal e-waste recycling sites in Kumasi
3. Peri-urban growth and the WEFE nexus: Land, food and ecosystem pressures in Greater Lomé and Yaoundé
4. A gender-responsive WEFE Nexus framework for methane mitigation in smallholder livestock systems: The role of micro-livestock in Sub-Saharan Africa
5. Critical review of soil–water–energy dynamics in tillage operations: Implications for energy efficiency and mechanised farming in Nigeria
6. Agroforestry for ecosystem resilience and sustainable land productivity in the Guinea and Sudan Savanna zones of Ghana: A scoping review
7. Gender–Indigenous Knowledge Intersections driving agroforestry–livestock systems for climate resilience in smallholder Africa
8. Breaking the cycle: A Transdisciplinary framework for the climate-food-health nexus to safeguard vulnerable populations in Africa

Abstracts

ORAL – WATER

001 Nature-based water treatment as an essential part of the Water-Energy-Food-Ecosystem Nexus at the Water Hub living lab

Linke Felicia[1]; Schill Rebecca[1]; Fry Anthony[2], Winter Kevin[2]; Gondhalekar Daphne[1], Koch Konrad[1], Drewes Jörg E.[1]

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Abstract

Global challenges such as the impact of climate change, the loss of biodiversity, and the strain on natural resources translate into local-scale challenges. In this case study, we examine the Water Hub Living Lab in Franschhoek, South Africa, where local river water used for irrigation is heavily contaminated by organic and inorganic waste streams emanating from an informal settlement upstream due to a lack of capacities and incentives for proper environmental management. At the Water Hub, we apply the WEFE (Water-Energy-Food-Ecosystems) Nexus approach to develop sustainable solutions for the community and to reuse local resources. The Water Hub also serves as a benchmark project for other communities in the region and around the world. A nature-based water treatment system combining a biofilter and the Sequential Managed Aquifer Recharge Technology (SMART) provides treated water using next-generation nature-based solutions (NbS) for water reuse leading to crop irrigation. Based on previous studies, the SMART approach does not require a chemical treatment step for pathogen inactivation. Additionally, it can enhance the biodegradation of moderately or poorly degradable trace organic chemicals such as diclofenac, an anti-inflammatory drug. The horizontal biofilters consist of gravel and locally sourced biochar, whereas the SMART bioreactor uses water works sand. Pumps and sensors are powered off-grid by solar panels combined with battery storage. The treatment train has been in operation for several months, with ongoing monitoring to track water quality and ensure safe irrigation for crops eaten raw. Crops irrigated with reused water and grown by locally hired gardeners are sold at local markets. Additionally, a pilot-scale biogas plant produces gas and organic fertiliser from local food waste at a rate of 100 kg per day. Finally, the restoration of the local riverbed has led to an increase

in indigenous plants, birds and reptiles, as well as improving flood protection. First results of the implemented water treatment train show water quality improvement regarding pathogens (e.g., removal of *E. coli*) and nutrients (e.g. phosphate). Analysis of trace organic chemicals is ongoing and enhanced biodegradation is expected after a several- month adaptation phase of the microbiome of the SMART bioreactor. To ensure the safety of the reclaimed water, the quality of the irrigation water is constantly monitored and a risk assessment will be conducted. Based on the current development, we can already see improvements in water, energy and food security for the local community, as well as ecosystem benefits, by using the WEFE Nexus approach. This translates into job creation, capacity building and educational benefits for the community. Close monitoring and assessment of the ongoing implementation of the different Nexus sectors (WEFE) will improve our understanding of the impacts, synergies and challenges of Nexus implementation and institutionalisation. This is especially important for a possible transfer to other locations and an adaptation to local conditions.

002 Biochar as a sustainable filter media in nature-based solutions for water reuse in the Water-Energy-Food-Ecosystems (WEFE) Nexus context

Kwadwo Yeboah Asamoah[1], Anjali Dav[1], Luisa Marie Otte[1], Tobby Abura[1], Felicia Linke[1], Alexander Boakye Marful[2], Daphne Gondhalekar[1]

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Abstract

Sub-Saharan Africa is constrained by a plethora of challenges including water, energy and food insecurity. The degradation of ecosystems threatens to further exacerbate these challenges thereby increasing the socio-economic vulnerability of local populations, hence contributing to an increase in climate-induced migration. To accelerate efforts to achieve the Sustainable Development Goals in Sub-Saharan Africa, a paradigm shift from siloed solutions to more holistic solutions such as the WEFE Nexus approach is essential.

Nature-based solutions such as constructed wetlands provide an opportunity to implement decentralised and low energy-demand wastewater treatment systems which have been shown from research to be able to provide quality water for agricultural irrigation leading to socio-economic development and restoration of ecosystems in vulnerable communities thereby demonstrating the effectiveness of the WEFE Nexus approach. This research project seeks to investigate the underlying filter media characteristics (surface functional groups, zeta potential, specific surface area) and removal mechanisms (adsorption, physical straining) that enable locally available and sustainable biochar produced from the pyrolysis of organic waste (coconut husks and cocoa pod) to be used as filter media in nature-based solutions that demonstrate water reuse in agriculture. Laboratory column experiments were run for 3 weeks at the Chair of Urban Water Systems Engineering of the

Technical University of Munich to conduct this investigation. Secondary effluent from the Garching Wastewater Treatment Plant in Bavaria, Germany was supplied by a peristaltic pump at a flow rate of 1.8ml/min from bottom to top through 7 glass columns (2 columns filled with coconut husk biochar, 2 columns filled with cocoa pod biochar, 2 columns filled with Granular Activated Carbon and 1 column filled with glass beads to serve as a control). The concentration of pathogens such as Escherichia coli, F-RNA phage (MS2 bacteriophage), Saccharomyces cerevisiae (Yeast) in the influent and effluent water from the columns were continuously measured. Data collected from the results of the experiment were analyzed with Python and used to generate column breakthrough curves to assess the efficacy of the three different types of biochar in the percentage reduction and log reduction of the different concentrations of the different indicator pathogens found in the secondary effluent.

Results from the experiments show that the locally produced biochar was successfully able to demonstrate a pathogen reduction from the secondary effluent that was comparable to the reduction results observed from the more expensive Granular Activated Carbon. It can be concluded that biochar depending on the feedstock, pyrolysis conditions and properties presents a sustainable locally available and low-cost filter media that can be applied in the design of nature-based water treatment systems to enable non-potable water reuse in agriculture. Biochar can be utilised in low-cost nature-based solutions to enhance water security at low energy demands to restore ecosystems and provide safe water for food production and socioeconomic development in the context of Water-Energy-Food-Ecosystem Nexus security.

003 Performance of a drip irrigation system for tomato production in Timéré (Niamey suburban area in Niger) with solar energy

Boubacar Ibrahim[1], Nafissatou Boubacar Amadou[2], Moustapha Adamou Mahaman[2], Mariama Hainikoy[3], Bernhard Tischbein[4], Sarah Verleysdonk[4]

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Abstract

Market gardening is now the main activity for many households in the west African Sahel. This activity is seen as an adaptation strategy under the ongoing climate change. Many households have implemented a small irrigation system (with solar pumping system) for vegetable production during the long dry season. Tomato is one of the most produced vegetables in the region. The aim of this study is to assess the performance of two irrigation systems for tomato production: the hand

watering can system and the drip irrigation system. The test was conducted at the experimental site of Timéré, located in sub-urban area of Niamey, on the right bank of Niger river. The data were collected through an agronomic trial set up in a block and plot system with three (3) blocks and six (6) control plots. Observations were made on the growth parameters (number of leaves, number of fruits, plant diameter, height number, fruit weight, fresh biomass, dry biomass), as well as on the soil moisture level which was determined before and after irrigation. The analysis of the results showed a high variability between the two systems for agro-morphological traits. Statistical analyses showed that drip irrigation has no significant effect on vegetative growth parameters. However, the assessment of hand watering shows that this method, although traditional and simple to implement, has significant limitations in terms of efficiency and water management. It requires a lot of time and physical effort and too much water is wasted. The different yields are: 18t/ha for hand watering and 15t/ha for drip irrigation. The two yields showed an important potentiality of tomato production in the region. Thus, market gardening contributes significantly to food security and households' income improvement. The irrigation system from photovoltaic water pumping system from river or borehole is highly contributing in the valorisation of the Water-Energy-Food nexus.

Key words: Performance, irrigation system, moisture content, drip irrigation, hand watering, tomato, Water-Energy-Food nexus.

004 Managed Aquifer Recharge for local Water-Energy-Food-Ecosystems Nexus resource security: Insights from a living lab in Niger

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Abstract

Groundwater resources in semi-arid regions worldwide are increasingly threatened by climate change and overexploitation. Managed Aquifer Recharge (MAR) methods using harvested rainwater offer a promising approach to restoring groundwater levels, mitigating local water scarcity, and balancing seasonal water availability. As such, MAR can generate multiple co-benefits for local agricultural value chains, ecosystem regeneration, and reduced energy demand for water supply. In this way, MAR represents a nature-based solution within the context of the Water-Energy-Food-

Ecosystems (WEFE) Nexus. Although the WEFE Nexus concept, initially introduced as a primarily theoretical framework in 2011, is increasingly being translated into practice, MAR remains an underleveraged approach. Different technical MAR methods, such as infiltration, direct injection, or semi-direct injection systems, can be adapted to site-specific conditions. However, limited data on local hydrogeology and water quality, as well as insufficient evidence on community acceptance, are often obstacles to MAR implementation, particularly in rural African contexts. Pilot studies are therefore essential for generating data and accelerating the adoption of MAR technologies with the aim of strengthening WEFE Nexus resource security.

The innovative project RETO-DOSSO, funded by the German Federal Ministry of Research, Technology and Space (project period: 07/2020-12/2026), addresses these challenges through a pilot study in Fandoga, a village of approximately 600 inhabitants in the municipality of Hamdallaye in Tillabéri, Niger, located around 20 km from the capital Niamey. In Fandoga, seasonal precipitation patterns cause local flooding during the rainy season (June – September), while water for household use and irrigation becomes scarce during the dry season. Groundwater is the main water source, with water table depths ranging between 17 and 27 m. Through the implementation of rainwater harvesting and MAR infrastructure, the project aims to balance water availability throughout the year by capturing and storing surface runoff. To support this objective, local climatic, hydrogeological, geological, soil, and socio-economic data are being collected to assess water availability and demand patterns. Based on these findings, infiltration trenches are being constructed to capture excess surface runoff during the rainy season. Infiltration wells will enable water to percolate into the aquifer for subsurface storage. Complementary activities, such as the construction of Demi Lune recharge structures on surrounding slopes, are intended to support local ecosystem regeneration.

The storage of surface runoff in the aquifer is expected to improve groundwater availability during the dry season. In addition, reduced soil erosion and enhanced soil moisture retention are anticipated to improve agricultural conditions, thereby strengthening local agricultural value chains and the economic resilience of local farmers.

Beyond the immediate project objectives, the RETO-DOSSO pilot study is expected to generate valuable data on the practical implementation of MAR and to demonstrate its potential for enhancing WEFE Nexus resource security in agricultural communities in Niger and comparable semi-arid regions. As a “living lab,” the project site can serve as a model for replication in similar rural contexts, thereby facilitating the sustainable transfer and scaling of results. By combining climate adaptation, resource recovery, and sustainable water infrastructure, the project provides valuable practical experience for operationalising the WEFE Nexus at the local level.

ORAL – ENERGY

001 Nothing left to steal: the attenuation paradox and the educational toll of the water-energy nexus in Ghana

Yaw Asante[1]

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Abstract

Policy often treats energy and water as isolated technical challenges, yet for children in Ghana, these deprivations form a single constraint on their education. This study examines the combined effect of energy poverty and water-access burdens on children's study time and academic progress. Using data from the Ghana Living Standards Survey (GLSS7), I estimate a Heckman selection model with instrumental variables to address selection bias and endogeneity.The findings show that multidimensional energy poverty (MEP) reduces weekly homework by 2 hours. Similarly, children relying on unimproved or surface water lose 1.8–1.9 hours relative to those with safely managed access. These deficits drive cumulative structural delays, with energy poverty associated with a lag of about 2 years in educational age. Children from poor water access households, relying on unimproved and surface water, face about 1 and 2 years of educational age lag as a result of both late enrollment and repetition. Rural girls face the most severe educational penalties, with energy poverty reducing their weekly homework by about 2 hours more than that of rural boys. Accounting for evening electricity hours, rather than a simple grid connection, increases the estimated homework penalty of energy poverty by 35% to 2.7 hours. Interestingly, the interaction between these deprivations reveals an "attenuation paradox": the marginal harm of energy poverty on children's education is most severe for children with basic water access. While generally, children facing both deprivations spend less time on homework and suffer from educational age lags, as a household moves down the water access ladder, toward poor water sources, the incremental harm of energy poverty on children's education diminishes. This shows the presence of a floor effect in these deprivations. For those lacking both, homework time is already so low that additional resource shocks have little left to steal. These findings provide strong evidence that energy and water deprivations are mutually reinforcing comorbidities. I argue that infrastructure investments for SDG 6 (Water) and SDG 7 (Energy) must be integrated to break the human capital trap. The government should synchronise electrification with water projects to ensure that time saved from one chore isn't immediately swallowed by another. Creating solar-powered community study centres could decouple a child's educational potential from the resource deficits of their home. While recent studies on energy poverty are considering the multidimensional energy poverty index, new studies must incorporate the electricity hours available to households into the index to avoid underestimation of the impact. This study provides the first evidence of an "attenuation paradox" in the water-energy nexus. The study identifies a floor effect where dual deprivation compresses educational engagement to a biological minimum.

It further demonstrates that binary grid-access measures underestimate educational penalties by 35% compared to reliability-weighted metrics.

002 Temperature Effects on Cocoa Husk Biochar and Bio-Oil Composition using an Improved Traditional Kiln

David Kabutey Akuaku[1],[*] Shadrack Kwadwo Amponsah[2], Kodwo Miezah[3], Jerome Dela Lavie[1], Theophilus Frimpong[2], Francis Kemausuor[1]

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Abstract

Cocoa husks are an abundant yet underutilised agricultural residue with strong potential for sustainable biochar and bio-oil production. This study investigates the effect of pyrolysis temperature on the yield, physicochemical properties, and functional performance of cocoa husk–derived products produced using an improved traditional kiln, addressing inconsistent product quality common in conventional systems in sub-Saharan Africa. Cocoa husks were pyrolyzed at 300 °C with a residence time of 18 hours and at 500 °C with a residence time of 14 hours, and the resulting products were comprehensively characterised. Results show a clear temperature-dependent trade-off between yield and quality. Biochar yield decreased from 52% at 300 °C to 41% at 500 °C due to intensified devolatilisation, while the iodine number increased from 136.7 to 338.9 mg g^{-1}, indicating enhanced microporosity and adsorption capacity. At 500 °C, fixed carbon content reached 43.6%, pH exceeded 11 signifying enhanced alkalinity and mineral concentration beneficial for acidic soil correction, and the higher heating value (HHV) peaked at 17.33 MJ/kg at 300°C but slightly declined at 500°C due to extensive devolatilisation. Carbon concentration increased to 63%, reflecting greater aromaticity, thermal stability, and long-term carbon sequestration potential. XRD, SEM, and FTIR analyses confirmed the transformation from lignocellulosic structures to a highly porous, amorphous aromatic carbon matrix. Higher pyrolysis temperature also improved bio-oil yield and quality, increasing production from 3.006 kg to 5.761 kg and calorific value from 15.2 to 20.7 MJ kg^{-1}, with reduced moisture and acidity. Mass balance analysis indicates that 300 °C favours solid carbon retention, whereas 500 °C promotes energy-dense bio-oil formation. Overall, controlled temperature operation enables targeted dual valorisation of cocoa husks for soil amendment, pollutant adsorption, renewable energy generation, and carbon sequestration.

ORAL – FOOD

001 Antibiotic use and antimicrobial resistance in ruminant livestock in Africa: A Systematic Review

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Abstract

Antimicrobial resistance is a growing concern for animal health, food safety, and public health, particularly in African livestock systems where regulations on antimicrobial use are limited. This review aimed to provide evidence-based insights to inform policy, promote surveillance and responsible antibiotic use within the One-Health approach. We systematically synthesised current evidence (from January 2015 to July 2025) in Africa on the drivers, patterns, prevalence, and genetic determinants of antibiotic use and resistance in ruminant livestock production. Across the reviewed studies, antibiotics were widely and often empirically used, with tetracyclines, βlactams, aminoglycosides, sulfonamides, macrolides, and fluoroquinolones mostly used. Farmers commonly obtained these drugs from informal outlets for use with limited veterinary guidance, minimal diagnostic input, and poor adherence to withdrawal periods. Consequently, bacteria isolated from ruminants exhibited high resistance to the antimicrobials frequently used by farmers. Notably, Escherichia coli isolates demonstrated high resistance to β-lactams and tetracyclines, whilst Salmonella spp. and Staphylococcus spp. isolates also demonstrated substantial resistance to ampicillin, tetracycline, and streptomycin. The bacterial isolates in most studies were also resistant to multiple antimicrobials. Consistent with these phenotypic patterns, resistance determinants such as βlactamase genes (blaTEM, blaSHV, blaCTXM), tetracycline (tet) genes, aminoglycosidemodifying enzyme genes and macrolide resistance genes (erm, msr) were frequently detected. These results demonstrate that AMR in the African ruminant production system is a persistent and systemic challenge requiring coordinated One Health actions, including improved antimicrobial stewardship, stronger regulation of veterinary drug supply chains, and expanded access to veterinary and diagnostic services for responsible antimicrobial use.

002 Comparative Characterisation of the Physicochemical and Functional Properties of Three Date Fruit Varieties Marketed in Tamale, Ghana

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Abstract

Date fruit (Phoenix dactylifera L.) is a nutritionally rich food source with promising culinary and health applications. However, comprehensive studies on the characterisation of the physicochemical and functional properties of date fruits, particularly for varieties traded in West African markets, remain scarce. This study aimed to characterise the physicochemical and functional properties of three date fruit varieties (Medjool, Maktoom, and Barhee) sold on the Ghanaian market, to generate evidence for their optimal selection in food product development. Samples of the three varieties were randomly procured from multiple sellers in Tamale, sorted, cleaned, dried, and milled into powder. Physicochemical and functional analyses were then conducted using standard protocols. The data were subjected to one-way analysis of variance at a 5% significance level, with mean separation performed using the Tukey post hoc test.The results revealed statistically significant ($p < 0.05$) differences among the three date fruit varieties across multiple quality parameters. Medjool dates stood out for their superior visual appeal, recording the highest colour intensity and visual quality parameters, suggesting a more vibrant and consumer-attractive appearance. Medjool dates also offered the highest protein content (3.43%), the greatest oil absorption capacity (236.22%), and the highest bulk density, properties that collectively position them as well-suited for premium food formulations. Maktoom dates, in contrast, demonstrated a distinct functional advantage, recording the highest water absorption capacity (337.68%), swelling capacity (2.80 g/g), and swelling index (2.63 ml/ml), alongside the highest fibre content (1.98%) and the lowest pH (4.21), characteristics that favour moisture-retentive and health-oriented applications. Medjool and Maktoom varieties also shared significantly higher total soluble solids than Barhee, reflecting greater sweetness intensity. Importantly, all three varieties exhibited moisture content below 10% and consistently high carbohydrate levels (>82%), with no significant differences in moisture, fat, ash, or carbohydrate content, underscoring their shared value as reliable, high-energy food ingredients.The findings indicate that while Medjool, Maktoom, and Barhee date fruit powders share common nutritional properties, each variety carries a distinct functional identity that can be strategically leveraged in food processing. Medjool dates are best suited for products where visual appeal, protein enrichment, and fat-binding are priorities, while Maktoom dates are more appropriate for fibre-rich, acidic, or high-moisture-retention formulations. Barhee dates, occupying an intermediate position across most parameters, offer versatility for a range of general-purpose applications. The consistently low moisture content across all powdered varieties further supports their potential for extended shelf life, making them commercially viable functional ingredients for the Ghanaian and broader West African food industry. This study provides the first comparative characterisation of the physicochemical and functional properties of three date fruit varieties marketed in Ghana, offering evidence-based guidance for broadening the industrial utilisation of the date fruit varieties in West Africa and supporting efforts toward food diversification and nutrition security.

003 Optimising Seedling age for climate-smart water productivity in upland rice: Atmospheric Demand-Moderated AWD response under screenhouse conditions

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Abstract

Water-saving rice management is increasingly important for climate-smart agriculture in sub-Saharan Africa, where evaporative demand and seasonal water uncertainty threaten staple crop production. Alternate wetting and drying (AWD) irrigation, which mimics prevalent irregular rainfall patterns, is widely recognised as a promising strategy for reducing water use, but its performance depends on complementary agronomic decisions and the environmental conditions under which it is deployed. This study evaluated if seedling age could be optimised to improve the water productivity of upland rice varieties under AWD and examined whether ambient weather variables, interpreted as atmospheric demand rather than as direct treatment, moderated the magnitude of the crop response under screenhouse conditions. A 4 × 5 × 2 screenhouse experiment consisting of upland rice varieties, seedling age and watering regime was laid out in a factorial fitted into a randomised complete block design in three replications and repeated using 15 kg of inland valley soil per plot at the Federal University of Agriculture, Abeokuta (FUNAAB), Ogun State, Nigeria. Data were collected on water usage, grain yield per plant, water productivity, root dry weight and volume, total dry matter, and phenological traits. Weather records for the study periods were obtained from the weather station and used to characterise the atmospheric environment of the screenhouse through mean temperature, relative humidity and derived vapour pressure deficit (VPD). Mean air temperature ranged between 25.7 and 30.3°C; afternoon relative humidity was from 32.4 to 65%; and derived afternoon VPD was from 1.22 to 2.53 kPa, indicating a warm, moderate-to-high evaporative demand environment. Across treatments, AWD substantially improved the yield-water balance. Mean water use declined from 87.9 L/plant under flooded conditions to 75.28 L/plant under AWD, representing 14.4% water savings, with mean grain yield and grain water productivity increasing from 39.64 to 44.98 g/plant and 0.456 to 0.599 g/L, respectively, indicating a 31.4% improvement. Flowering occurred slightly earlier under AWD than under flooded conditions. Under AWD, 15-day-old seedlings produced the best overall combination of high grain yields, low water use, and superior water productivity. The strongest individual treatment for grain yield was NERICA® 8 transplanted at 15 days, whereas Ofada transplanted at 15 days recorded the highest water productivity. The atmospheric conditions moderated specific AWD effects, as the YEAR × water regime interaction

was significant for water use and root dry weight and volume at maturity but not for grain yield or water productivity, indicating that atmospheric demand mainly altered the magnitude of plant water extraction and root adjustment while the yield advantage of AWD remained broadly stable. These findings reveal that AWD should be promoted as a climate-smart management package that combines water regimes, optimal seedling ages, and responsive genotypes. For upland rice under tropical conditions, approximately 15-day-old seedlings under AWD offer a practical pathway to stronger roots, improved water productivity and more water-secure upland rice production.

004 Quality and Safety of minced meat: A Systematic Review of Adulteration and Its Public Health Implication

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Abstract

Minced meat products are among the most vulnerable foods to adulteration due to their processed nature and the difficulty in visually identifying meat sources. This systematic review examined global trends, detection methods, and public health implications of minced meat adulteration, emphasising challenges in developing regions. Peer-reviewed articles published between 2010 and 2024 were analyzed following PRISMA guidelines to assess patterns of adulteration and technological advances in detection. Findings showed widespread practices including species substitution, mislabeling, and the blending of spoiled or low-quality meat, driven largely by economic motives and weak enforcement mechanisms. Such adulteration compromises consumer trust, violates religious standards, and exposes the public to microbial, allergenic, and chemical hazards.Technological developments have significantly improved detection capabilities. Molecular-based tools such as PCR, LAMP, and CRISPR assays provide high accuracy and rapid field-level testing. Spectroscopic methods, including near-infrared and fluorescence spectroscopy combined with chemometrics, enable non-destructive screening, while proteomic and metabolomic techniques enhance the authentication of processed meats. The integration of artificial intelligence and machine learning into these systems has further increased efficiency and predictive accuracy. Despite these advances, limited laboratory capacity, lack of harmonised standards, and poor traceability remain major obstacles in many countries. Strengthening regulatory systems, standardising detection protocols, investing in portable analytical tools, and promoting consumer awareness are critical for ensuring authenticity and protecting public health.

Keywords: Minced meat, Adulteration, Food fraud, Authentication, Public health, Detection technologies

005 Effect of Formulated Organic Fertiliser and Inorganic Fertiliser on Cucumber Growth and Yield in Ferric Acrisols

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Abstract

This study evaluated the effects of formulated organic fertiliser and inorganic fertiliser on cucumber (*Cucumis sativus L.*) growth and yield in ferric acrisols under tropical conditions in Ghana. The study aimed to determine the suitability of integrated nutrient management strategies involving food waste, poultry manure, cow manure, cocoa husk biochar, and NPK fertiliser for improving cucumber productivity and soil fertility in degraded ferric acrisols. The experiment was conducted at the CSIR-Crops Research Institute, Fumesua, Ghana, using a Randomised Complete Block Design (RCBD) with ten treatments and three replications. Treatments consisted of different combinations of food waste, poultry manure, cow manure, cocoa husk biochar, and NPK fertiliser (15:15:15). Organic amendments were applied at 5 t ha^{-1}, while NPK fertiliser was applied at 200 kg ha^{-1}. Growth parameters measured included plant height, stem girth, leaf length, and leaf width, while yield parameters included fruit length, fruit diameter, number of fruits per plant, fruit weight per plant, and total yield. Soil physicochemical properties and amendment characteristics were also analyzed. Results showed that the ferric acrisol soil was moderately acidic (pH 5.66), sandy loam in texture, low in nitrogen (0.1155%), and moderate in phosphorus and potassium. Treatments integrating organic amendments with inorganic fertiliser significantly enhanced cucumber growth and yield compared with sole organic treatments. The highest cucumber yield was obtained with sole NPK fertiliser (99.40 t ha^{-1}), followed closely by cocoa husk biochar combined with NPK fertiliser (82.07 t ha^{-1}), which was statistically comparable to the inorganic fertiliser treatment. Integrated treatments involving food waste and NPK fertiliser also produced improved vegetative growth and moderate yields. In contrast, treatments based solely on food waste or partially integrated organic amendments recorded significantly lower growth and yield performance due to slower nutrient mineralisation and limited nutrient availability during critical growth stages. The formulated organic amendments exhibited high nutrient content, alkaline pH, and substantial organic matter levels, indicating their potential to improve acidic tropical soils.The study concludes that integrated nutrient management involving cocoa husk biochar and inorganic fertiliser provides a sustainable strategy for improving cucumber growth and yield in ferric acrisols. While inorganic fertiliser ensured immediate nutrient availability, the incorporation of organic amendments enhanced soil quality, nutrient retention, and moisture conservation. The findings demonstrate the potential of converting agricultural and food

wastes into value-added soil amendments for sustainable vegetable production and improved soil fertility management in tropical agroecosystems.

006 Composting Dynamics and Quality Characterisation of Cocoa Husk Biochar–Based Organic Fertiliser

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Abstract

Composting of food waste represents an effective strategy for organic waste valorisation and nutrient recovery. This study evaluated the composting dynamics and final compost quality of food waste amended with cow manure, poultry manure, and cocoa husk biochar under controlled turning conditions. Seven treatments (T1–T6) and a control were composted for 75 days with twice-weekly turning. Composting performance was assessed through temperature evolution, moisture dynamics, pH, electrical conductivity, mass reduction, and pathogen indicators, while compost quality was evaluated based on nutrient composition, C:N ratio, and heavy metal concentrations. All treatments exhibited typical composting temperature profiles, reaching thermophilic conditions within 5–7 days. Peak temperatures ranged from 45–59 °C, with poultry manure–amended treatments achieving the highest temperatures, indicating enhanced microbial activity and effective sanitisation. Moisture content declined from initial values of 44–68% to 16–25% at maturity due to microbial heat generation and evaporation. Substantial mass reductions (43–82%) indicated efficient organic matter degradation. Final composts exhibited alkaline pH (8.5–10.4), electrical conductivity below 6.5 mS cm^{-1}, and increased nutrient concentrations, with total nitrogen ranging from 2.35–3.87%, phosphorus from 0.55–1.37%, and potassium from 4.69–5.72%. Final C:N ratios ranged from 4.46–16.92, indicating mature compost products. Heavy metal concentrations remained well below regulatory limits, while ***Salmonella*** was absent and ***Escherichia coli*** levels were below the recommended threshold of 1.0×10^3 CFU g^{-1} for compost intended for agricultural use, consistent with US EPA Class A biosolids standards. Poultry manure amendments enhanced composting efficiency and nutrient enrichment, while cocoa husk biochar contributed to improved compost stability and nutrient retention. These findings demonstrate the potential of combining food waste, livestock manure, and cocoa husk biochar to produce nutrient-rich, hygienically safe compost suitable for sustainable soil fertility management.

ORAL – ECOSYSTEM

001 Economic analysis of agroforestry systems in Tunisia: A multi-scale evaluation of private and social profitability

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Abstract

This paper aims to provide decision-makers with a robust economic tool to evaluate agroforestry alternatives in Tunisia. Its primary objectives are to identify and estimate the private and social benefits of these systems, justify necessary investments, and identify potential financing mechanisms, such as Payments for Environmental Services (PES). The research addresses the urgent need for sustainable land management to face the estimated $2.17 billion annual cost of land degradation in Tunisia in 2021. The Cost-Benefit Analysis (CBA) framework, is applied to compare "with" and "without" intervention scenarios over a production cycle period using an accurate discount rate. It integrates biophysical modeling to quantify sediment retention, soil protection and carbon sequestration. Economic valuation techniques include market price methods for provisioning services, voluntary market price for carbon sequestration and replacement cost methods for regulating services (to assess sediment retention and soil protection). Sensitivity analyses were conducted to account for risks related to price fluctuations, yields, and climate-induced uncertainties. Case studies across diverse Tunisian landscapes reveal critical insights:

- **Barbara Watershed (Acacia):** Acacia plantations increase net annual income by 3 to 7 times after nine years. Though, such intervention involves initial losses for the first five years after the plantation, mainly for grazing prohibition. These systems provide significant social benefits through sediment retention and carbon sequestration.
- **Ain Snoussi Forest (Cork Oak):** Financial analysis shows a conflict for declining forests where the inaction scenario is more profitable for private actors, whereas intervention through artificial regeneration is socially more profitable but only at lower discount rates.
- **Zoghmar Cropland (Cactus/Olive):** Integrated cactus/barley systems demonstrate a higher private and social profitability compared to traditional barley cultivation. Conversely, rainfed olive plantations are economically discouraged, while irrigated olives remain profitable even when accounting for water degradation costs.

In conclusion, integrating economic dimensions is essential for designing high-performance agroforestry systems. Private and social interests often diverge, while policy tools must be adapted to support multi-use management. Recommendations include developing innovative financing mechanisms like carbon credits and PES to encourage sustainable management and offer "green

solutions" to international markets for carbon and biodiversity conservation. This research provides a comprehensive framework for evaluating the trade-offs between private and social income in Tunisian agroforestry systems. It allows the integration of ecosystem service valuation—spanning local, national, and global scales—into strategic policy recommendations. Furthermore, it identifies specific agroforestry systems combinations (e.g., cactus-intercalary systems) that provide viable alternatives to inaction in dryland areas.

002 A multi-objective optimisation model of land use allocation for the 'Greater Northern African Region': A case study from Yirgachefe, southern Ethiopia

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Abstract

Agroforestry provides multiple socioeconomic and ecosystem service benefits at farm and landscape scales. These benefits are especially important in the climate-vulnerable 'Greater Northern African Region' (GNAR), encompassing North Africa, the sub-Saharan Sahel and the Horn of Africa. Many communities in the GNAR have long practised agroforestry systems, while others face barriers to adoption. Meanwhile, land use decisions at multiple scales will determine the capacity of communities to adapt to future market, productivity, policy and environmental changes. To best support these land use decisions, multi-criteria decision analysis provides an important tool to evaluate synergies and trade-offs between the benefits of different land uses, including in the context of uncertain future scenarios. As part of the EU Horizon 'TRANS-SAHARA' project, a prototype 'Robust multiobjective optimisation model' is presented, initially focusing on a case study from the Yirgachefe Living Lab area in southern Ethiopia. The model optimises land use allocation according to a set of socioeconomic and ecological indicators and the preferences of local farmers and experts. The performance of land uses for each indicator is quantified through a combination of primary and secondary data sources: a ranking-and-scoring exercise and cost-benefit analysis collected through a household survey and focus group discussion, local agricultural production and price data, and published literature. Weights are assigned to indicators according to local experts' preferences and varied to reflect hypothetical scenarios. The model notably incorporates uncertainty, minimising the level of potential losses to reflect typical risk aversion in land use decisionmaking and ensuring that resulting optimal land use portfolios never fall below the performance floors for any single objective. Time dynamics are introduced to the model for the first time in the agroforestry context, allowing for improved predictive capacity. The output is a single optimal landscape and supports tradeoff analysis. The impact of a range of scenarios can be potentially explored: i) private land tenure vs. customary land tenure systems, ii) climate change, land degradation, timber, crop or

carbon price changes, or agricultural intensification, iii) policy interventions, novel financial support mechanisms and/or risk reduction strategies. An online Decision Support Tool is in development to allow decisionmakers to access the model and adapt it to their local context.

003 From Arid Land to Oasis: Evidence from a long-term WEFE Nexus practice in Southern Madagascar

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Abstract

Southern Madagascar faces chronic water scarcity, climate variability, and ecosystem degradation, constraining agricultural productivity and food security. While the WEFE Nexus is promoted as a framework for climate-resilient development, empirical evidence from long-term, field-based systems in arid African contexts remains limited. This study assesses a real-world WEFE Nexus practice in a dairy farming system to evaluate its sustainability, trade-offs, and replication potential.A case study approach was applied using field observations, retrospective system analysis, and resource flow mapping across water, energy, food, and ecosystem components. A conceptual WEFE Nexus framework was used to analyze system interactions. A simplified composite Nexus Index was applied based on normalised indicators, including water use efficiency, renewable energy utilisation, food system self-sufficiency, and ecosystem performance. Groundwater access, combined with agroforestry development, solar energy use, and adaptive farming practices, has enabled the transformation of approximately 30 hectares of arid land into a functional agroecosystem within a dairy production system. The system integrates approximately 700-750 coconut trees and livestock production (≈22 cattle), producing around 50 liters of milk per day. Water is sourced from a shallow well (~7 m depth), with 5–6 hours of daily pumping, of which approximately 90% is used for irrigation. Observed fluctuations in groundwater levels during pumping indicate the sensitivity of the aquifer and the need for balanced water management. The energy system is predominantly solar (~80%), enabling low-carbon operation while supporting water access and production activities. Agroecological practices, based on manure recycling and the absence of chemical inputs, contribute to soil stability and increased biodiversity. The food component reflects both synergies and trade-offs within the Nexus. Approximately 30% of livestock feed is cultivated on-site, while about 60% relies on naturally occurring pasture that requires no irrigation or external inputs, reducing pressure on water and energy resources but increasing vulnerability to rainfall variability. The remaining 10% consists of external feed supplements (e.g., cottonseed cake, maize & rice bran) used to complement livestock nutrition. Previous small-scale crop production for human consumption existed but is currently limited, allowing partial land recovery. The Nexus Index indicates a moderate level of sustainability (≈0.5–0.6), with strong performance in ecosystem restoration, renewable energy use, and integrated resource use, but constraints in food system resilience and water-use

efficiency. Planned rainwater harvesting (54 m³ storage) represents a key opportunity to enhance system resilience and reduce pressure on groundwater. This case provides empirical evidence that WEFE Nexus systems can emerge through practice-based processes in arid environments. It highlights that effective implementation requires continuous adaptation and management of interdependencies and trade-offs. Improving irrigation efficiency, strengthening feed autonomy, and integrating complementary water sources are essential to enhance sustainability. While full self-sufficiency may not be achievable or optimal, a balanced combination of local production and targeted external inputs supports system stability. Increasing local production, where conditions allow, can further enhance resilience and overall Nexus performance. The findings contribute to bridging the gap between WEFE Nexus theory and practice and provide actionable insights for scaling climate-smart, low-carbon solutions for water-secure development in Africa.

004 Stakeholder-Informed Design of the NEXSOL WEFE Nexus Tool for Climate-Resilient Agroforestry Planning

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Abstract

Agroforestry is recognised as a nature-based pathway for strengthening climate resilience, restoring landscapes and supporting rural livelihoods in dryland and semi-arid regions. Although agroforestry interventions may address climate- and water-related livelihood challenges, their effectiveness depends on social-ecological fit, local vulnerabilities and governance conditions (Kmoch et al., 2024). Therefore, agroforestry intervention planning cannot be treated as a purely agricultural or ecological question. Choices about tree species, land-use allocation, irrigation, carbon storage and ecosystem restoration create interconnected impacts across Water, Energy, Food and Ecosystems (WEFE) systems. An intervention that improves food production may increase water demand; restoration may enhance ecosystem services and carbon sequestration but also affect land availability or farm income. These interdependencies make agroforestry planning a multi-objective decision problem requiring tools that take a Systems Thinking approach in order to reveal trade-offs and synergies. Within the TRANS-SAHARA project, NEXSOL is being developed as a WEFE Nexus-based decision-support tool to translate model outputs into practical guidance for agroforestry intervention planning in the Living Lab locations, i.e., Chad, Djibouti, Ethiopia, Ghana, Senegal, Tunisia NEXSOL integrates three modelling components: a WEFE Nexus model for assessing cross-sectoral indicators and trade-offs across water, energy, food, ecosystems, greenhouse gas emissions and socio-economic dimensions; an optimisation-based agroforestry and land-use allocation model for exploring socio-

economic and environmental costs and benefits under scenarios; and agroforestry suitability mapping based on spatial multi-criteria analysis.

Studies on environmental and land-management decision-support systems emphasise that stakeholder co-design, interviews, questionnaires and iterative usability testing are essential for ensuring that tools are relevant, usable and trusted by policy and planning stakeholders (Jelokhani-Niaraki et al., 2023; Stankovics et al., 2024; Ziegler et al., 2025). To ensure that NEXSOL responds to user needs, we propose a structured stakeholder requirements survey targeting the groups likely to use or operationalise the tool: local farmers, researchers and technical analysts, Living Lab implementing teams, local and regional planners, public authorities, and extension services. The survey will collect requirements related to decision contexts, expected outputs, data availability, spatial scales, preferred indicators, acceptable model complexity, visualisation needs, uncertainty communication and usability barriers. Specific question blocks will address requirements for the land-use allocation model, including scenario assumptions, land-use constraints and socio-economic variables; for the WEFE Nexus model, including priority KPIs, trade-off interpretation considering natural resource constraints and policy relevance; and for agroforestry suitability mapping, including criteria weighting, spatial resolution, local validation and interpretation of suitability classes.

The expected contribution is a stakeholder-informed requirements framework that links model development with practical decision-support needs. By integrating stakeholder feedback early in the tool design process, NEXSOL can better balance analytical capacity with usability, transparency, and local relevance. The survey results will inform the prioritisation of tool functions, dashboard design, visualisation choices, terminology, guidance materials, and validation workflows. More broadly, this work aims to demonstrate how stakeholder engagement can move beyond consultation toward the co-design of decision-support tools that are technically credible, context-sensitive and actionable for agroforestry intervention planning under WEFE Nexus constraints. These findings will have implications for contexts facing infrastructure planning challenges across Africa and beyond.

005 Forging a new user-friendly data-efficient Water-Energy-Food-Ecosystems (WEFE) Nexus model in TRANS-SAHARA

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Abstract

As the compounding effects of climate change take centre-stage in global discussions, implementation of appropriate adaptation and mitigation measures have to be significantly accelerated to achieve the UN SDGs especially in developing countries. Incorporating scientific research results to shape policy interventions is crucial to protect vulnerable populations from climate impacts. Cross-sectoral policy development promises huge potential impact, but policies are typically sectoral as policy- and decision-makers often lack the required tools for cross-sectoral analysis. Water-Energy-Food-Ecosystem (WEFE) Nexus modeling tools have emerged to identify potential trade-offs and synergies between different sectors, to inform decision-making. However, application of existing WEFE Nexus tools is limited in Africa due to data scarcity at local and catchment levels, which limits cross-sectoral impact potentials. The innovative TRANS-SAHARA WEFE Nexus modelling tool builds on existing modelling tools to include frameworks for estimating the trade-offs and synergies between water, energy, food and ecosystems. The tool will be deployed to guide local farmers and decision-makers engaged in the development of sustainable climate-smart agroforestry projects. The model has a dedicated data scraping plug-in in an open-source GIS tool, to search national and international databases to provide realistic proxy values to circumvent data gaps. The model will also illustrate the effects of the choice of tree species for agroforestry activities on the regional climate and water balance by modeling the long-term effects of the agroforestry systems using different Representative Concentration Pathways scenarios. This will guide the choice of species selection to support ecosystem regeneration. Lastly, the model will incorporate alternative water sources and less explored renewable energy sources such as biogas as valuable resources that can augment the supply of water and energy. The innovative TRANS-SAHARA WEFE Nexus modelling tool will serve as a tool to support the design and implementation of Nexus-based agroforestry management practices and policies to accelerate integrated climate change adaptation and mitigation measures in data scarce regions.

006 The First Step to a Giant Leap: A Pilot Experience of the Potential Industrial Symbiosis Network in Ghana

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Abstract

The transition to a circular economy requires innovative frameworks that can identify, optimise, and visualise resource exchanges among industries. Industrial Symbiosis (IS), a key enabler of this transition, remains largely underdeveloped in Ghana due to inadequate digital 'match-making platforms', low awareness of IS, and data scarcity. This study presents a pioneering effort to simulate a theoretically constructed industrial symbiosis network (TCISN) using real-world data from 95 small and medium-scale enterprises across key industrial sectors in Ghana. A combination of geospatial analytics, network theory, and optimisation algorithms were used to model and visualise waste-to-resource exchanges through a digital, GIS-enabled interface. The TCISN reveals scale-free topologies with key hub industries such as cement, metal smelting, agro-processing, manufacturing and recycling sectors driving material recovery through highly connected exchanges. Slag, carbon black, aluminium and steel scraps, palm kennels emerged as the most frequently exchanged by-products, suggesting strong potential for material reuse. Spatial clustering, centrality analysis, and community detection further identified high-synergy zones and underutilised resource flows. The TCISN indicates a moderate level of circular integration, recording a system-wide circularity potential of 0.43. The findings provide a replicable model for circular industrial development in emerging economies, underscoring the viability of a data driven IS platform tailored to the Ghanaian context. They demonstrate the potential of digital matchmaking systems to enhance circularity, inform policy, and guide sustainable industrial planning. This pilot model offers a foundational blueprint for developing an operational IS tool in Ghana and may catalyze broader systemic shifts toward resource-efficient industrial ecosystems.

POSTER – WATER

001 Water-Energy-Food nexus governance in the Caribbean (Barbados and Jamaica) for climate justice.

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Abstract

The 1992 Rio Conference first recognised Small Island Developing States (SIDS) as a specific group of islands highly vulnerable to extreme weather conditions, climate change and global economic shocks. Both Barbados and Jamaica fall within this category. This creates resource vulnerability which is mostly attributable to its geography and size making them sensitive to exogenous stressors and with minimum capacity to respond. In response to these resource challenges, a loosely defined Water, Energy, and Food nexus at local level has started to emerge. The Water-Energy-Food-Ecosystem Nexus (WEFE Nexus) approach highlights the interdependence of water, energy and food security and ecosystems – water, soil, and land – that underpin that security. The WEF nexus ensures that resource-based solutions do not secure one resource at the expense of another resource. Furthermore, the WEF nexus can empower communities to participate in managing the interconnected systems they depend on. This can foster equitable access to resources, essential for resilience and adaptation through integrated governance. The WEF nexus addresses how resource scarcity and climate impact disproportionately burden disadvantaged and marginalised communities. The WEF nexus is a critical framework that can be used to achieve climate justice. However, the WEF nexus is not yet operational due to the gap that exists in the legislative and institutional structures. In water, energy and food statutes there is a complete lack of recognition of integrated resource management.In addition to this, there is a lack of intergovernmental frameworks in Barbados and Jamaica. This abstract examines the legislative and institutional gaps within the WEF nexus to achieve climate justice objectives in SIDS with a focus on Barbados and Jamaica. The abstract focuses on whether governance sector disparities in Barbados and Jamaica limit equitable and sustainable climate adaptation outcomes. Particularly, it examines the absence of explicit rights to water, energy and food where state obligations are ambiguous especially for low-income communities. It raises the question of whether the mechanisms that exist are sufficient for there to be equitable access and distribution of resources in a disaster-prone community. The abstract uses a doctrinal legal research methodology. It will examine primary, secondary, and tertiary sources of law in Barbados and Jamaica. The primary sources will be inclusive of the Barbados Water Authority Act Cap. 274A, Electricity Act 2015(Jamaica), The Constitution of Barbados 2002, Jamaica's Charter of Fundamental Rights and Freedoms, Water Resources Act 1995 (Jamaica), Water Reuse Act 2023 (Barbados) and the United Nations Framework Convention on Climate Change (UNFCCC) and the

United Nations Paris Agreement. It is submitted that despite both Barbados and Jamaica making advances to implement WEF frameworks, the failure to integrate a nexus based legal approach constrains the effective realisation of climate justice. A decentralised WEF nexus can ensure that climate benefits are realised through local knowledge, inclusive governance and marginalised voices as the central position in decision making. The identification of the key gaps in the legal and institutional frameworks will allow contributions to the emerging scholarship on nexus governance in SIDS. It will also focus on the operationalisation of the WEF nexus through legal frameworks in Barbados and Jamaica. It offers a possible map of integrated governance transformation that is aimed at coordination across sectors and improvement of climate justice outcomes in SIDS.

002 Water use, livelihoods, and sustainability: analysing blue water footprints in smallholder vegetable production in northern Ghana

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Abstract

Water use is central to sustaining livelihoods, however increasing pressures from climate change, population growth, and governance challenges threaten freshwater availability and long-term sustainability. In rural and peri-urban communities of the Global South, water insecurity undermines food security, income generation, and social equity, highlighting the need for integrated approaches that link water, energy, and food systems with livelihood perspectives. Despite methodological advances, persistent gaps remain in harmonising social sustainability indicators and integrating behavioural dimensions into water use research. This literature synthesis therefore seeks to address these gaps by examining empirical and conceptual evidence on the interconnections between water use, livelihoods, and sustainability, with a focus on identifying frameworks, methodological contributions, and spatial scales that inform policy and practice. A systematic review approach, guided by PRISMA principles, was employed to identify and synthesise relevant studies published between January 2015 and March 2026. Literature was retrieved from major academic databases, including PubMed, Web of Science, MEDLINE, EMBASE, Google Scholar, JSTOR, and Semantic Scholar. Inclusion criteria emphasised methodological rigor, empirical evidence, and relevance to water use, livelihoods, and sustainability. Narrative synthesis was used to integrate findings thematically, given the heterogeneity of study designs. The review employed several analytical tools to structure and interpret findings. Automation tools assisted in duplicate removal and preliminary screening, while manual cross-checking ensured reliability. Frameworks such as the Analytical

Hierarchy Process (AHP) and TOPSIS were used as reference points to evaluate the robustness of included studies. Hydro-economic models and composite indices provided comparative benchmarks for assessing how different studies linked water management strategies with livelihood outcomes. Narrative synthesis was then organised thematically, guided by these methodological lenses, allowing for structured comparison across heterogeneous study designs. **Results:** AHP and TOPSIS informed how trade-offs between efficiency, equity, and sustainability were interpreted, while hydro-economic models highlighted integration of biophysical and socioeconomic dimensions. Livelihood sustainability indices guided thematic coding of social assets and resilience factors. The review highlights the importance of integrated natural resource management for sustainable livelihoods, promote environmental livelihood security, equity, and resilience in the face of global change, and reveals how methodological innovations can strengthen evidence synthesis and inform policy-relevant insights.

Keywords: Water footprint evaluation; Sustainable livelihoods; Governance and equity; Water–Energy–Food (WEF) Nexus; AHP; TOPSIS

003 Adsorption of tetracycline and metronidazole residues from landfill leachate using biochar from shea nut shell

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Abstract

The improper disposal of unwanted or expired pharmaceuticals has led to an increase in the detection of pharmaceutical pollutants, including metronidazole and tetracycline, in landfill leachate. Because these residues are persistent and have the potential to contribute to antibiotic resistance, they pose significant threats to the environment and human health. The study assessed the influence of dosage, temperature, and resident time on the adsorption efficiency of shea nut shell biochar for tetracycline and metronidazole. Biochar was produced from shea nut shells via pyrolysis at 500 °C for 20 min. The surface functional groups were confirmed by Fourier transform infrared (FTIR), and amorphous and crystalline structures were revealed by X-ray diffraction (XRD) for shea nut shell biochar. The scanning electron microscopy (SEM) results revealed the porous nature of the biochar and a major energy dispersive X-ray (EDX) carbon composition of 84.54% for shea nut shell biochar. Maximum removal efficiencies of 95.96% for tetracycline and 98.97% for metronidazole were achieved at a temperature of 45 °C and 35 °C, respectively and an equilibrium contact time of 60 min. Increasing the biochar dose from 0.50 g to 1.50 g significantly improved the removal efficiency from 78.96% to 94.97% for tetracycline, and 88.27% to 98.97% for metronidazole at a residence time of 60 min, and a temperature of 35 °C. By adjusting the temperature from 35 °C to 45 °C, it was found that the removal efficiency of tetracycline increased from 80.79% to 88.97% at a contact time of 60 min, and metronidazole increased from 87.55% to 91.32% at a contact time of 15 min. Adsorption data fitted well with the Langmuir isotherm model and pseudo second order kinetics model with correlation

coefficients (R^2) of 0.9196 and 0.9995 respectively, indicating chemisorption on a homogeneous surface. Shea nut shell biochar is a promising low-cost and environmentally friendly adsorbent for removing antibiotic residues from landfill leachate. Through biochar application, pharmaceutical pollution in water bodies might be greatly reduced whilst adding value to agro-waste.

Keywords: Adsorption, Biochar, Pharmaceuticals, Leachate, and Water Treatment.

004 Comparative hydrological assessment of conditionally merged rainfall data and satellite-based rainfall products in a data-scarce tropical basin

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Abstract

Reliable rainfall data are essential for hydrological modelling; however, in data-scarce basins, sparse and discontinuous gauge records introduce substantial uncertainty into streamflow simulations. Satellite rainfall products (SRPs) offer spatially continuous estimates, yet their hydrological performance varies significantly and is often basin-specific. The hydrological benefit of conditionally merged rainfall datasets, which integrate satellite-based rainfall with in-situ observations, remains insufficiently evaluated across diverse flow conditions. This study assesses a conditionally merged rainfall dataset (CMRD) and nine SRPs for streamflow simulation, evaluating their performance under varying hydrological conditions in the Pra River Basin, Ghana, using the Soil and Water Assessment Tool (SWAT). The SWAT model was calibrated for 2003–2009 and validated for 2000–2002. Model performance was assessed using the coefficient of determination (R^2), Nash–Sutcliffe efficiency (NSE), root-mean-square error ratio (RSR), and percentage bias (PBIAS), with additional analyses of long-term variability, seasonal dynamics, and extreme flow conditions. Results show that rainfall input exerts a dominant influence on model performance. The CMRD consistently outperformed all SRPs, achieving optimal calibration (R^2 = 0.86; NSE = 0.86; RSR = 0.38; PBIAS = −4.4) and satisfactory validation (R^2 = 0.66; NSE = 0.60). TAMSAT, CHIRPS, W5E5v2, and PERSIANN-CDR reproduced seasonal dynamics but underestimated peak flows. The CMRD improved high-flow representation, while TAMSAT, W5E5v2, and PERSIANN-CDR performed better under low-flow regimes. Model performance declined under extreme conditions, indicating limitations in modelling hydrological extremes. These findings demonstrate that merging satellite and gauge data improves

rainfall representation and streamflow simulation, thereby supporting hydrological modelling and water resources assessment in data-scarce basins.

005 Adsorptive Removal of Iron and Manganese Using Optimised Activated Carbon

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Abstract

Access to safe drinking water remains a major challenge in many developing regions in Africa, including Ghana. This is particularly due to the presence of elevated iron and manganese concentrations in groundwater sources. This study investigates the development and optimisation of coconut shell activated carbon derived from agricultural precursors for the efficient removal of Fe^{2+} and Mn^{2+} ions in aqueous systems. The adsorbent was prepared through chemical impregnation and carbonisation under varying conditions, including impregnation ratios (1:1, 1:2, and 1:3), particle sizes (0.6, 1.0, and 2.0 mm), and carbonisation temperatures (400–600 °C). The prepared adsorbent was characterised by FTIR, SEM, XRD and BET techniques. The adsorptive performance of coconut shell activated carbon was investigated for Fe^{2+} and Mn^{2+} removal from aqueous medium in a batch adsorption studies with additional optimisation using the Response Surface Methodology (RSM). The influence of operational parameters such initial metal ion concentration, adsorbent mass, and initial solution pH on equilibrium uptake was systematically studied. The results indicated that the adsorptive capacity (q_e) decreased with increasing adsorbent mass, whilst the efficiency improved, indicating a redistribution of available binding sites at higher adsorbent dosage. The study indicated a strong dependence of the adsorptive capacity on the initial solution pH. Equilibrium data were modelled using Langmuir, Freundlich, Temkin and Dubinin – Radushkevich (D–R) isotherms with. The **D–R** model provided the best fit suggesting that adsorption process was predominantly physisorption with mean free energy value below 8 $kJmol^{-1}$. Kinetic analysis revealed that the pseudo-second order best described the kinetics of adsorption, indicating that the rate limiting step was governed by surface interactions involving valence forces and not only mass transfer. Ultimately, the CSAC demonstrated strong potential as an efficient, low cost, and sustainable adsorbent for iron and Manganese removal from contaminated water, supporting its utilisation in decentralised treatment systems.

006 Enabling the Scale-Up of Treated Wastewater Reuse in Accra, Ghana: A Policy Mix Analysis

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Abstract

Treated wastewater reuse is increasingly promoted as a pathway towards more sustainable urban water management, yet many initiatives remain confined to pilot and demonstration settings. This paper examines why the transition from demonstration to scale-up remains difficult in Accra, Ghana, using a demonstration case as an empirical case of treated wastewater reuse for urban vegetable irrigation. The study adopts a qualitative embedded case-study design informed by an adapted policy-mix approach. Drawing on national policies and documentation, published relevant literature on policy mixes, sustainability transitions and wastewater reuse, the analysis examines the policy environment surrounding treated wastewater reuse in terms of policy consistency, policy comprehensiveness and scale-up implications. Methodologically, the paper adapts the extended policy-mix concept by focusing on the relevant action situations, policy domains, governance levels and instrument types affecting the reuse pathway. The findings show that treated wastewater reuse in Accra has demonstrated technical and operational promise, but that scale-up is constrained primarily by weaknesses in the surrounding policy mix rather than by technical feasibility alone. The most significant constraints are the absence of formal legal recognition for reclaimed water, weak standards and compliance pathways, limited support for distribution and monitoring infrastructure, insufficient incentives for user uptake, and fragmented coordination across water, sanitation, agriculture and urban-planning domains. The analysis further shows that the policy environment is not defined mainly by overt contradiction, but by limited comprehensiveness: key instruments needed to move from demonstration to wider uptake are missing or underdeveloped. The paper concludes that scaling treated wastewater reuse in Accra requires more than general policy support for circularity or innovation. It requires a more complete and targeted policy mix that combines legal recognition, standards, infrastructure support, demand-side measures and cross-sector coordination. In this respect, the principal challenge is institutional rather than purely technical. The paper makes two main contributions. First, it provides a Ghana-specific policy analysis of treated wastewater reuse in Accra that is not clearly present in the published literature. Second, it extends the application of policy-mix analysis to circular water solutions by showing how scale-up constraints can stem not only from inconsistency between policies, but also from weak policy comprehensiveness and the absence of instruments required to support transition beyond the demonstration phase.

007 Seasonal Variation in Physicochemical Parameters and Heavy Metal Contamination in Rivers within the Abuakwa South Municipality of Ghana

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Abstract

Water quality is a key determinant of public health, economic development, and ecological balance. In rapidly growing communities, natural processes and human activities particularly mining and agriculture can compromise the integrity of water resources. The Birim River and its tributaries are vital for domestic and agricultural use, yet they face increasing pressure from these stressors. This study aimed to assess the seasonal variability of physicochemical parameters and heavy metal (HM) concentrations across eleven sites along the Birim River and its tributaries, namely Atiwa, Apapam, Adadientem, Kibi Deaf, Nsu Abrewa, Oben ne Obeng, Okyerema, Appetite, Supong, Esikam, and Steel Bridge. Water samples were collected and analyzed for Fe, Mn, Ni, Cr, Cu, Zn, As, and Hg using a PerkinElmer PinAAcle 900T atomic absorption spectrophotometer after acid digestion. Physicochemical parameters, including pH, electrical conductivity (EC), total dissolved solids (TDS), dissolved oxygen (DO), turbidity, total suspended solids (TSS), and biochemical oxygen demand (BOD), were also measured to capture seasonal variations. Results showed marked seasonal differences. During the dry season, TDS (401 mg/L) and EC (548 µS/cm) peaked at Esikam, while pH fluctuations were recorded at Okyerema and Oben ne Obeng. Turbidity (556.67 NTU at Okyerema) and TSS (100 mg/L at Supong) were significantly higher during the wet season, whereas BOD increased in the dry season, indicating greater organic pollution. Heavy metal contamination was also more pronounced during the dry season, with high levels of Cr and Mn at Atiwa and Apapam, respectively, and Ni exceeding WHO guidelines at nearly all sites. These findings demonstrate the strong influence of seasonal dynamics on water quality in the Birim River system. The results underscore the pressing need for monitoring and targeted interventions to protect public health and aquatic ecosystems.

008 Explainable machine learning for flood risk classification across all 16 administrative regions of Ghana using GloFAS discharge and CHIRPS rainfall data (2000–2025)

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Abstract

Riverine floods disrupt water storage, hydropower generation, food production, and ecosystem stability across all 16 administrative regions of Ghana, yet no region-specific, interpretable flood risk tool exists for operational use. This study presents an explainable machine learning framework for daily riverine flood risk classification across all 16 Ghana regions, trained on 25 years of integrated hydrological data drawn from GloFAS river discharge reanalysis (Copernicus Emergency Management Service) and CHIRPS dekadal rainfall indicators (WFP/HDX). Flood risk is defined operationally as days where regional discharge exceeds the historical 95th percentile, a region-relative threshold that accounts for the 310-fold discharge variation across Ghana's river systems, from 1.57 m^3/s in Ahafo to 485.73 m^3/s in Oti, and avoids the pitfalls of absolute thresholds on a dataset spanning small upland streams to the Volta basin. From 111 million raw GloFAS grid-point observations, a rigorous four-stage data pipeline produced 151,456 region-day records spanning 2000–2025, resolving spatial, temporal, and version-control challenges to achieve complete coverage of all 16 regions with zero missing values. Three tree ensemble classifiers (Random Forest, XGBoost, LightGBM) were trained on 2000–2020 data and evaluated on a 2021–2025 holdout set of 28,736 observations, a genuinely harder evaluation period with a flood rate of 6.4% against 4.7% in training. LightGBM achieved the strongest performance: AUC-ROC 0.9998, F1 0.9724, Precision 0.9662, and Recall 0.9788. External validation against the Dartmouth Flood Observatory matched 12 of 18 in-scope riverine events (66.7%), a strong result for an independent database that includes event types the model was not designed to detect. Three misses were dry-season or pre-season events outside the model's riverine scope, and three were genuine model failures concentrated in southern Ghana's shorter, flashier river systems. SHAP analysis reveals that regional geography contributes 34.83% of total prediction importance, reflecting the vast discharge variation across Ghana's basins, followed by current discharge and seasonal position. Most notably, real-time 10-day rainfall ranks 24th of 26 features. This is not because rainfall is irrelevant but because river discharge in reanalysis data already integrates upstream rainfall that fell days earlier, while historical rainfall climatology ranks 4th. In a forecast-based deployment, current rainfall features are expected to regain primary importance. At 30.3% of September region-days classified as flood events, September carries the highest flood concentration of any month, followed by October at 17.9%, both aligned with the West African Monsoon peak. January through April record zero events. The SHAP explainability layer enables NADMO district offices to act on specific hydrological evidence rather than probability scores alone, directly supporting anticipatory harvest decisions for Northern and Savannah region

farmers, pre-positioning of emergency supplies, and coordinated water level management with Volta basin hydropower operators. These applications address the water, energy, food, and ecosystem connections at the core of this summit. Integration of GloFAS medium-range ensemble forecasts is underway to convert the system into a 3 to 10 day operational early warning tool.

POSTER – ENERGY

001 Modelling Porosity Dynamics in Sand Microbial Fuel Cells: A Systematic Review

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Abstract

Sand microbial fuel cells (SMFCs) are bio-electrochemical devices that treat organic-laden wastewater and generate electricity by harnessing the metabolic activity of naturally occurring bacteria within sediment matrices, positioning them as a compelling technology for the water-energy nexus in resource-constrained settings across Sub-Saharan Africa. A critical and overlooked process limits their reliable deployment: as electroactive biofilm colonises the sand pore network over time, matrix porosity declines, progressively choking substrate supply, altering hydraulic flow, and degrading electrical output — yet no published computational model has incorporated this time-varying porosity evolution into a sand SMFC simulation. To close that gap, a PRISMA 2020-compliant systematic search was conducted across Scopus, and ScienceDirect covering 2001–2025, from which 14 peer-reviewed studies were systematically selected and analysed for porosity characterisation, transport behaviour, and electrochemical performance. Four principal findings emerge: none of the 14 primary papers incorporates a dynamic porosity evolution equation into a sand SMFC model, confirming the central gap this work addresses; lattice Boltzmann methods — validated in the corpus against experimental data — constitute the most appropriate computational framework for pore-resolved sand SMFC simulation, with a consensus parameter set established for direct model initialisation; bio-clogging evidence demonstrates that colony-type biofilm growth reduces hydraulic conductivity by two to three orders of magnitude at biovolume fractions as low as 0.03% of total pore volume, a result entirely unrecoverable under the homogeneous biofilm assumptions of all current models; and, critically for system design, matrix porosity and organic matter loading are co-determining variables — a SMFC at lower initial porosity but higher organic content outperforms a higher-porosity, substrate-poor configuration by up to 175% in output voltage, directly challenging the prevailing assumption that maximising porosity optimises performance. This review synthesises, for the first time, a closed five-field governing equation set — encompassing substrate transport, bio-electrochemical kinetics, biomass growth, porosity evolution, and coupled charge conservation — providing a physically rigorous and computationally tractable foundation for

designing sand-based SMFCs as scalable, low-cost water treatment and energy recovery systems with direct implications for constructed wetland design, decentralised sanitation infrastructure, and sustainable energy access across Sub-Saharan African communities.

002 Type-II van der Waals heterostructures of SiC/Al_2OS monolayers for Photocatalysis and Optoelectronics Applications

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Abstract

The quest for high-performance photocatalysts that efficiently harness visible light for hydrogen generation via water splitting remains a central challenge in the field of renewable energy research. Two-dimensional van der Waals heterostructures have received significant attention because of their tunable bandgaps and efficient charge separation. This computational study introduces a two-dimens ional van der Waals heterostructure composed of silicon carbide (SiC) and Janus aluminum oxysulfide (Al_2OS) monolayers as a superior candidate for this application. Through first-principles density functional theory calculations, we demonstrate that the SiC/Al_2OS heterostructure is stable thermodynamically, dynamically, mechanically and thermally. The heterostructure formed a type-II band alignment with a bandgap of 1.91 eV, which is ideal for promoting the spontaneous separation of photogenerated charge carriers and thereby mitigating detrimental electron-hole recombination. The calculated band edge positions were optimally aligned to drive both the hydrogen and oxygen evolution reactions across a broad pH spectrum from 0 to 8, enabling unbiased overall water splitting. The work function was reduced to 4.38 eV for the SiC/Al_2OS heterostructure compared to the individual monolayers, confirming electron transfer from SiC to Al_2OS and built in electric field. Additionally, the composite structure exhibited a pronounced enhancement in visible-light absorption compared to its isolated constituent layers. These results provide theoretical evidence that the SiC/Al_2OS van der Waals heterostructure is a robust and efficient material platform for solar-driven hydrogen production.

POSTER – FOOD

001 Sustainable food crop systems in northern Ghana: A scoping literature review

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Abstract

The food crop systems in the Northern regions of Ghana are the most vulnerable particularly due to relatively dry climate, heavy reliance on rain-fed crop farming by majority of farmers and negative impacts of climate change. As population growth continue to rise, adopting sustainable food crop production practices in these regions to ensure adequate quantities and variety of foods, while preserving the economic, social and environmental conditions is crucial. This scoping review mapped the current literature (2020 onwards) on sustainability of food crop systems in northern Ghana. The assessment of the sustainability of the food systems focused on soil fertility, climate suitability for crops, water efficient agricultural practices, food processing facilities and storage infrastructure. To identify literature that satisfy the inclusion criteria, a systematic search of Google Scholar, Scopus, and ScienceDirect databases was conducted. The search identified 5,897 literature, from which 63 met the inclusion criteria. Majority of the final selected literature focused on climate suitability for crops (n = 23) and soil fertility (n = 15). Studies exploring food systems in northern Ghana have overly focused on production systems that is mainly rainfed, substantially neglecting post-production activities. Soils in northern Ghana have low to moderate inherent fertility and the climate has become progressively drier over time. Conservation of soil and water were barely practiced, with consequent low crop output. Food processing is generally small scale and marketing is mainly local. Furthermore, the lack of cold storage facilities contributes to the considerable post-harvest losses. The seemingly high vulnerability of the food system in northern Ghana highlights the need for policy making and interventions towards achieving sustainability or resilience of food systems in northern Ghana to ensure positive economic, social and environmental impacts. This review covered broader indicators of sustainable food crop production in all the current regions of Northern Ghana.

Keywords: sustainable food crop production, Northern regions of Ghana, scoping review, rain-fed crop farming

002 Catalytic upcycling of cocoa pod husk lignin to aromatic monomers

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Abstract

Cocoa pod husk (CPH), an abundant agricultural residue in Ghana, represents a valuable waste substrate for sustainable biomass conversion and lignin valorisation. The catalytic conversion of CPH lignin was studied under mild aqueous NaOH conditions at 110 °C for 16 h to produce well-defined aromatic monomers. Three terpyridine-based catalytic systems were tested: mononuclear Rh–terpyridine, binuclear Rh–Rh–terpyridine, and Cu–terpyridine. Product distributions were analyzed using MALDI-TOF MS, GC–MS, and NMR spectroscopy. The mononuclear Rh–terpyridine system achieved the highest oil-phase yield, 71.2% of the initial lignin in CPH, and selectively produced four main aromatic ketones: acetovanillone, propiovanillone, acetosyringone, and syringylpropanone, consistent with β–O–4 bond cleavage within the lignin structure. The binuclear Rh–Rh–terpyridine complex generated similar compounds with slightly lower efficiency. Conversely, the Cu–terpyridine catalyst produced only 29.4% oil and mainly guaiacyl-type monomers. MALDI-TOF MS spectra showed that monomer peaks dominated Rh-catalysed reactions, whereas Cu-catalysed reactions displayed higher-mass signals at 332.4, 334.0, 336.0, and 374.2 Da, suggesting dimeric species. Proton NMR confirmed these trends, displaying strong aromatic and methyl ketone signals near 7.0 and 2.6 ppm, respectively, in the Rh-derived products, and much weaker signals in the Cu-derived oil. These results highlight the superior monomer selectivity and efficiency of Rh–terpyridine systems and suggest that Cu-based catalysts could serve as cost-effective alternatives for lignin valorisation.

003 Collaboration in farmer research networks (FRNS) supporting soil health innovation in Malawi

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Abstract

The worsening of soil health problems and poor agricultural productivity in Sub-Saharan Africa provides an opportunity to understand collaboration. This thesis examines collaboration as a strategy for addressing soil health problems in Kasungu, Mzimba and Ntcheu districts, in Malawi. Using a case study approach with 104 FRN farmers, the study first identified the actors involved in the FRN and then investigated the processes of collaboration in FRNs. Both quantitative and qualitative data were gathered on the socioeconomic categories of FRN farmers, their roles, and the decision-making process. Thirdly, focus groups with six FRN platforms and key informant interviews with three extension workers and researchers were used to evaluate the barriers and drivers of collaboration. Fourthly, to examine the implications of collaboration on soil health innovation, the study used individual case studies with 18 FRN farmers. The results from actor categories revealed that FRNs comprised of high percentage of women (70.4%), less educated and the poor farmers. Although this demonstrates the successful realisation of the FRN's principle of having farmers from marginalised groups represented meaningfully, which is also related to the collaboration's principles, the power to make decisions was skewed towards the male FRN farmers. Three issues regarding collaboration were observed: (1) facilitative leadership, (2) social capital, (3) commitment. Without addressing these issues, it is difficult to achieve practical collaboration and innovation. In terms of the implications on soil health innovation, several innovations that aim at improving soil health were identified, for instance (1) diversity, (2) human and social values and (3) co-creation of knowledge. This implies that farmers and extension workers were able to shift their thinking from top-down mode of agricultural research delivery to innovation systems thinking. This study suggests that, in addition to ensuring a diversity of farmer categories, more work needs to be done in giving marginalised farmers more power to make decisions. The study therefore suggests that a broader analysis of collaboration in FRNs at National level be conducted in order to understand how the different soil health innovations generated by farmers fit into formal research.

004 The Paradox of Pelt Value-Chain; Short-Term Food Security Against Long-Term Industrial Economic Growth in Ghana

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Abstract

In many developing economies, a significant portion of bovine hides, ovine and caprine skins, collectively termed pelts, is diverted for human consumption as a low-cost protein source. While this addresses immediate food security needs, it creates a profound "opportunity cost" by starving the domestic tanning and leather industries of essential raw materials. This paper argues for a strategic shift in the value chain, advocating for the redirection of hides and skins from the food market into industrial processing to unlock long-term economic and environmental sustainability. Through a comparative analysis of value-addition metrics, backed by studio-based and market research, the study demonstrates that the industrial transformation of a single hide into leather goods generates significantly higher socio-economic contributions, foreign exchange earnings, and employment opportunities than its sale and consumption as a food commodity. Furthermore, the research explores the environmental implications of this shift, highlighting how a structured leather value chain promotes the utilisation of byproducts and the principles of the circular economy. By addressing the socio-economic drivers behind "edible hide" markets, this paper proposes policy framework to ensure that pelts are recognised as industrial assets rather than dietary staples. Establishing this transition is critical for developing a robust, sustainable manufacturing sector that competes in the global bio-economy.

Keywords: Skins and hides, Low-cost protein source, Leather industry, Value-chain

005 Prospects for an indigenous knowledge–driven mechanised cassava production and bio-economy in Africa

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Abstract

Cassava is one of the most strategic food and industrial crops in Sub-Saharan Africa (SSA), contributing significantly to food security, employment, rural livelihoods, and industrial development. In recent years, SSA accounts for 65% of world cassava production, yet productivity remains substantially below global averages due to limited mechanisation, poor agronomic practices, inadequate processing technologies, and weak market integration. The lack of appropriate mechanisation solutions has limited cassava's ability to drive agro-industrial transformation and rural development in Africa. Mechanised cassava production presents significant opportunities to transform the cassava sector into a robust bio-economy that can drive industrialisation, renewable energy generation, climate resilience, and rural economic growth. Drawing lessons from studies in Ghana, this paper maps production bottlenecks, mechanisation pathways, and bio-economy opportunities. The objective of this paper is to review the current status, challenges, and prospects of mechanised cassava production and its role in developing sustainable and scalable cassava-based bio-economic solutions in SSA. One transformative innovation is the TEK Mechanical Cassava Harvester (*OAPI Patent 17192*)**,** an indigenous solution developed at KNUST to address the unique challenges of harvesting cassava roots grown in diverse soils. Unlike imported technologies, the TEK harvester innovation is locally adaptable, rugged, and cost-effective. Field evaluations show that the TEK mechanised harvester reduces harvest time to one sec/plant from 5-10 min/plant manually, root damage by up to 80%, and overall labour cost by more than 90%, making it a game-changer for smallholder and medium-scale farmers. Beyond harvesting, other mechanisation interventions developed include double-row disc and mouldboard ridgers that enhance land preparation efficiency, soil moisture conservation, precision planting, and weeding that improve crop spacing and stand establishment, and reduce labour-intensive manual weeding. Additional innovations such as tractor-drawn stem coppicers, motor-powered peelers and slicers that enable rapid harvest and postharvest processing, improved product quality, and enhanced value addition, particularly for women-led rural enterprises, are also being developed. The paper further discusses technological innovations, policy interventions, digital agriculture, value-addition opportunities, and sustainability considerations necessary to achieve large-scale transformation of the cassava value chain. The study concludes that integrated mechanisation, supported by research, infrastructure, financing, and policy reforms, can reposition cassava as a strategic industrial crop for Africa's bio-economy.

Keywords: Cassava mechanisation, bio-economy, Sub-Saharan Africa, value addition, industrial cassava, sustainability, food security.

006 Identifying critical attributes for maize raintree porridge development: A choice-based conjoint analysis approach

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Abstract

Malnutrition in Ghanaian infants is a significant issue because traditional foods like "***koko***" lack proteins and micronutrients. Integrating ***Samanea saman***, which is rich in proteins and minerals, into maize porridge is a proposed solution. While nutritional content is key, consumer acceptance and preferences are less well understood. Conjoint analysis helps identify consumer priorities when choosing a product. This study assessed preferences for maize–raintree pod porridge attributes, identified key sensory influences on choice, and demonstrated the role of conjoint analysis in complementary food development. The study involved mothers/caregivers of children aged 6–23 months in Sekondi-Takoradi Metropolis, Ghana, with 50 participants. Sawtooth Software was used for survey design and analysis. 45 product profiles were developed across 15 choice tasks based on factors such as product identification, added ingredients, preparation method, colour, taste, aroma, and aftertaste. The findings revealed that colour (18.32%), aroma (17.99%), and product identification (17.30%) were crucial attributes, with preferences for yellowish-white colour, nutty aroma reminiscent of "tom brown", and product identification as fermented dehydrated maize dough combined with roasted raintree seed flour. Visual and sensory cues significantly impact acceptance, possibly more than nutritional content does. Conjoint analysis provides insights into consumer trade-offs that go beyond simple surveys. The study concludes that conjoint analysis is effective for early product development in identifying key attributes.

007 Harnessing Underutilised Indigenous Starch Resources for Sustainable Biodegradable Film Development: A Circular Bioeconomy Approach to Reducing Plastic Pollution in Food and Water Ecosystems

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Abstract

The environmental burden of petroleum-based plastics in terrestrial and aquatic ecosystems has intensified the search for renewable and biodegradable alternatives. Within the Water–Energy–Food–Ecosystem (WEFE) Nexus, valorisation of underutilised crops provides opportunities to advance circular bioeconomy approaches that reduce plastic waste and environmental pollution. This study investigates the film-forming potential of starches extracted from *Icacina oliviformis* (false yam), *Colocasia esculenta* (wild taro), and *Alocasia macrorrhizos* (giant taro) as sustainable feedstocks for biodegradable packaging materials. Starches were isolated using wet milling and characterised through compositional analysis, FTIR, XRD, Rapid Visco Analysis, and ASTM mechanical testing. Significant differences ($p < 0.05$) were observed among starch sources. Starch yield followed *A. macrorrhizos* (10.81%) > *C. esculenta* (8.64%) > *I. oliviformis* (5.58%). The *I. oliviformis* exhibited exceptionally high amylose content (98.53%) and starch purity (90.00%), while *A. macrorrhizos* and *C. esculenta* were amylopectin-dominant with lower purity levels. Rheological analysis showed superior pasting behaviour in *I. oliviformis*, with higher peak viscosity (3391.7 mPa·s) and final viscosity (2513.7 mPa·s), supporting continuous and stable film formation. In contrast, *A. macrorrhizos* and *C. esculenta* exhibited limited film integrity, associated with higher protein content and structural heterogeneity. Mechanical testing confirmed that *I. oliviformis*-based films achieved higher tensile strength (6.5 MPa) and Young's modulus (222 MPa), indicating improved structural performance for packaging applications. In conclusion, the findings demonstrate that underutilised indigenous starch crops can serve as renewable feedstocks for biodegradable materials. This contributes to circular bioeconomy strategies aimed at reducing plastic pollution and supporting sustainable resource management within agro-ecosystems, water systems, and food production landscapes under the WEFE Nexus framework.

Keywords: Circular bioeconomy; biodegradable films; plastic pollution; indigenous starches; false yam; taro; giant taro; sustainable materials

008 Indigestible Foreign Material Ingestion in Ghanaian Goats: A Multi-Stakeholder WEFE Nexus Assessment

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Abstract

Goat meat is a routine protein source for many households across Ghana. However, the livestock system producing it operates under conditions many food system analyses overlook. Free-ranging animals forage in waste-saturated environments. At slaughter, indigestible foreign materials (IFM), including plastic bags, rope and synthetic textiles, metals are found in their reticulorumen. Within the WEFE nexus, this represents an under-recognised disruption affecting animal biology, food productivity and environmental quality. Reduced feed conversion efficiency in IFM-affected animals also represents wasted embodied energy in feed production and transport. Waste streams from abattoirs, containing biological pollutants and possible leachates from waste products may also find their way into water networks that may not be able to handle the load. The study looked at the awareness of IFM ingestion among stakeholders in the goat value chain and perceptions about the effects of IFM on the reticulorumen. We studied 64 stakeholders at Sabitui Musa Abattoir, Suame, Kumasi: farmers (n=20), animal traders (n=20), butchers/abattoir workers (n=20), veterinary officers (n=2) and environmental health officers (n=2). Stakeholders were grouped and selected during sampling periods. A questionnaire was designed to determine the frequency of IFM, observation of rumen abnormalities, awareness of rumen microbes, health and economic consequences. Analysis in R (v4.3.0) included descriptive statistics and chi-square tests for categorical variables. Goat farmers and traders regularly observed goats eating waste and butchers frequently encountered IFMs during evisceration. Butchers reported 60% of IFM animals had reticulorumen changes, like abnormal smell, colour and fluid consistency. These observations are in line with altered microbial fermentation and offer a foundation for future molecular microbiome assessment by Next Generation Sequencing. Reticulorumen microbiota was poorly understood: 45% of farmers and 40% of butchers knew that microorganisms are responsible for ruminant digestion. This has important practical implications because ingestion of IFM is then seen as a post-mortem blockage rather than a preventable microbial disease, which requires control at the source. Losses were noted across the chain: all farmers reported production losses, 90% of traders reported losses in the market and 60% of butchers reported moderate-to-severe changes in meat quality. This study offers the first multi-stakeholder evidence from Ghana of how widespread waste pollution is associated with losses in goat meat production, through a WEFE lens. It provides first-hand evidence of extensive ingestion of IFM and highlights. This identifies an “IFM-livestock-microbiome” nexus as a hidden WEFE interaction. These insights demonstrate how ecosystem degradation translates into animal health, thereby affecting food system productivity, water quality risks and livestock energy productivity. The next step is NGS evaluation of the microbiome of IFM-treated goats. Integrated meat inspection-based surveillance at abattoirs and extension materials are potential ways to gather these data. It’s already there; now we just have to use it.

Key Words: Rumen microbiome, waste pollution, Goat health, WEFE nexus, livestock production

009 Utilisation of de-starched cassava in fish feed development

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Abstract

The use of industrial de-starched cassava (a waste product in cassava starch production) as a cost-effective alternative binder to wheat in fish feed is limited by its low protein content, which can be improved by supplementing it with legume, cereal, and fishmeal as an alternative cost effective feed in a world of increasing aquaculture and fish farming; and high cost of fish feed in fish production. De-starched cassava (DC), maize (M), Gari (G), soybean (S), and fishmeal (F) were processed into composite flour and formulated into two feed sets, A and B: Set A (Feed 1, Feed 2, and Feed 3) with vegetable oil (V.O) fractions and Set B (Feed 4, Feed 5, and Feed 6) with shea butter (S.B) fractions. Boiling water (100 °C) was added to each mixture and stirred, minced using a mincer (Bosch MFW67440UC), oven-dried at 50 °C for 24 hours, cooled, and shaped into pellets. The pellets were analysed for proximate composition, mineral content, cyanide levels, and floatability. All formulated feeds met the FAO requirement for moisture (10%), crude fiber (8%), crude fat (5-15%), and total ash (16%) to suit both catfish and tilapia. Cyanide levels in the feeds ranged from 0.49 to 0.54 mg/kg, which fell below the 50 mg/kg standard. Mineral content included calcium (0.61-1.14%), phosphorus (0.87-1.27%), and magnesium (0.22-0.36%). Feeds made with shea butter expressed the highest floatability over those made with vegetable oil, making them more suitable for tilapia; with sample Feed 5 expressing 100% floatability throughout the period of study. Among the feeds, only sample Feed 5 met the carbohydrate and protein requirements for juvenile (30-35%) and first-stage adult tilapia (30-32%), as well as the grow-out stage for catfish (28-32%). Therefore, Feed 5 is recommended as a nutritious and safe option for juveniles and first-stage adults of Nile tilapia and the grow-out stage of African catfish, promoting optimal growth.

Keywords: De-starched cassava, fish feed, proximate composition, mineral composition, floatability.

010 Optimisation of nixtamalisation effects on the techno-functional properties of rice and fonio flours with implications for gluten-free bread development

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Abstract

Fonio (*Digitaria exilis*), an indigenous West African cereal and rice (*Oryza sativa*), a widely cultivated and consumed cereal are nutritionally valuable, gluten-free cereals that remain underutilised in value-added food applications. Their raw flours exhibit highly acidic pH values and high starch retrogradation tendencies limiting their suitability for gluten-free bread production. Nixtamalisation, an alkaline pre-treatment process is traditionally applied to cereals mostly corn to improve flour functionality and processing characteristics. This study investigated the optimisation of nixtamalisation process parameters to improve the techno-functional properties of two fonio cultivars (Namba and Yadima) and rice cultivar Agra with implications for gluten free bread development. A Box Behnken Design (BBD) comprising 17 experimental runs per cereal variety integrated with Response Surface Methodology (RSM) was employed to optimise three independent variables; lime concentration (0.2-2%w/v), cooking time (1-20minutes) and cooking temperature (70-100°C). Nine responses were measured for each experimental run which included pH, colour parameters (L* a* b*) and five pasting properties (Peak, Setback, Final Trough, and Breakdown Viscosities). Multi- response optimisation was performed using the desirability function approach with setback viscosity assigned the highest importance due to its critical role in predicting the staling rate of bread. Second order polynomial models were developed and validated using Analysis of Variance (ANOVA), adjusted R^2 and lack-of-fits test. Model quality varied among varieties with Fonio (Yadima) showing the strongest predictive capability producing 7 of 9 significant models ($p < 0.05$), particularly for setback viscosity (ADJ.R^2 = 0.883, F = 32.98, and $p < 0.001$), confirming reliable prediction of alkaline modification. Optimal nixtamalisation conditions were identified as 0.20% lime concentration, 89.3°C for temperature and 2.4 minutes for Rice (Agra) with desirability of 0.511; Fonio (Yadima), had optimal lime concentration of 0.71%, temperature 74.3°C and cooking time of 20 minutes and desirability = 0.340. For Fonio (Namba), 0.46% lime concentration, 72.1°C temperature and 13.2 minutes and desirability of 0.404. Under these conditions, all three varieties achieved the target pH values favourable for yeast fermentation and exhibited reduced setback viscosity relative to the raw flours. Setback viscosity decreased by 11.7-39.9% across varieties with Rice (Agra) demonstrating the greatest improvement from 1179 to 709cP approaching the wheat reference value of 592cP. These findings demonstrate that optimised nixtamalisation can significantly improve the functional performance of fonio and rice flours by reducing starch retrogradation tendencies. The study highlights the potential of these underutilised indigenous cereals for development of high-quality gluten free bakery products and broader value-added food applications.

Keywords*:* fonio, rice, nixtamalisation, optimisation, gluten-free bread

011 Optimised Nixtamalisation Conditions of Millet and Sorghum for Industrial Processing of Quality Gluten-free Bread Flour

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Abstract

Study focused on optimisation of nixtamalisation conditions of drought and heat-tolerant millet and sorghum for application in Gluten-free (GF) bread flour and products. The goal was to improve food and nutrition security and boost local economy. Nixtamalisation is pretreatment processing, which involve controlled cooking and steeping of grains in alkaline solution and have been used to improve other grains but less explored in millet and sorghum. Nixtamalisation was done by cooking 100 g of millet and sorghum grains with 200 mL water of 0.2%w/v, 1.1%w/v, 2.0%w/v calcium hydroxide solution for 20, 30 and 40min cooking time at varying temperatures of 70 °C, 85°C and 100°C in a total of 17 runs samples. Samples were steeped for 8 h at room temperature, nixtamal washed a*nd* dried at 65ºC for at least 12 hr to achieve moisture content below 10%. Dried nixtamal millet and sorghum samples were milled and seived to 125micron particle size. The study used a Response Surface Methodology's (RSM) Box Behnken Design (BBD) to study process predictability to optimise techno-functional properties of the cereals. The optimised nixtamalisation conditions for millet (Naad Kohblug) was 0.71 %w/v, 70°C, 20 min; Millet (Waap Naara); 0.59 %w/v, 100°C, 30 min and Sorghum (Dorado) was 0.71 %w/v, 100°C, 23 min. Millability test shows nixtamalisation improved finess of millet (Naad Kohblug) by 4.6% -12.6%, Millet (Waap Naara) by 3.0% and Sorghum (Dorado) by 8.8 -13.4%. Nixtamalisation was able to improve both techno-functional properties and millability of grains which is positive for industrial processing and product economics; easy milling with less energy consumption. Parity plots predictive strength aligned with established applications of RSM in food process optimisation. High predictability for pasting properties ($R^2 \geq 0.7$) and pH ($R^2 \geq 0.9$) implies the nixtamalised millet and sorghum flours are highly suitable for gluten-free bakery applications, since their functional properties can be reliably predicted and controlled; critical for overcoming the structural challenges in gluten-free dough or batter systems. Study also recommended that further exploration of a novel 'Hot steam nixtamalisation (HSNix) - assisted wet milling' of GF grains could potentially improve functionality of flour from GF-cereals when explored.

Keywords*:* sorghum; millet; gluten-free bread; flour quality; nixtamalisation; optimisation

012 Nutrigenomic potential of bambara groundnut (vigna subterranea) in modulating gene–diet interactions associated with type 2 diabetes

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Abstract

Type 2 diabetes mellitus (T2DM) is an increasing public health challenge globally, particularly in sub-Saharan Africa, where rapid urbanisation, dietary transitions, and lifestyle changes are contributing to rising prevalence rates. In Ghana, the growing burden of T2DM highlights the urgent need for affordable, culturally acceptable, and sustainable dietary strategies for prevention and management. Functional foods derived from indigenous crops offer promising opportunities for improving metabolic health while supporting sustainable food systems. Among these crops, Bambara groundnut has gained attention due to its high nutritional value, drought tolerance, and potential antidiabetic properties. This study aims to investigate the nutrigenomic potential of Bambara groundnut in modulating gene–diet interactions associated with T2DM. Specifically, the research seeks to determine the nutritional and bioactive composition of selected Bambara groundnut varieties, evaluate their effects on the expression of genes involved in glucose metabolism and insulin signalling, and correlate bioactive compound profiles with observed gene expression patterns. Bambara groundnut samples will be collected from selected production regions in Ghana and processed into flour for the extraction of bioactive compounds using aqueous and ethanol extraction methods. Nutritional and phytochemical analyses will be conducted to determine total phenolic content, flavonoid content, antioxidant activity, protein content, resistant starch, and dietary fibre. In vitro nutrigenomic assays will be performed using relevant mammalian cell lines associated with glucose metabolism. Cells will be treated with Bambara groundnut extracts, followed by RNA extraction, cDNA synthesis, and quantitative polymerase chain reaction (qPCR) analysis to assess the expression of diabetes-related genes, including INS, IRS1, GLUT4, AKT, PI3K, TNF-α, and IL-6. The study is expected to identify Bambara groundnut varieties with high bioactive potential and demonstrate the ability of their bioactive compounds to modulate key metabolic and inflammatory pathways associated with T2DM. Correlation analyses between phytochemical profiles and gene expression responses are also expected to provide insight into the specific compounds responsible for observed nutrigenomic effects. The findings will contribute to emerging research on gene–diet interactions and support the development of sustainable, food-based interventions for metabolic disease prevention. Additionally, the study promotes the utilisation of indigenous African crops as climate-resilient functional foods capable of improving nutrition and public health outcomes in resource-limited settings.

013 Evaluation of okra pectin as an alternative emulsifier in milk chocolate: Effects on rheological, textural, and sensory properties

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Okra (Abelmoschus esculentus) pectin is a potential new source of natural polysaccharide with gelling and emulsifying capabilities, which can be exploited industrially as functional ingredients in food and non-food products. This study evaluated the potential of okra pectin as a substitute for lecithin, an allergenic and increasingly costly emulsifier used milk chocolate production. Milk chocolate samples were formulated with 0.2% okra pectin, with 0.2% lecithin serving as the positive control. Rheological profiling (at 35°C and 60°C), texture analysis, and consumer sensory evaluation were conducted to determine the impact of incorporating okra pectin. All formulations exhibited shear-thinning flow behaviour however, chocolates containing okra pectin showed significantly higher viscosity values across measured shear rates compared with lecithin-based controls. Texture profile analysis revealed significant differences in gumminess and cohesiveness, while hardness, springiness, and other parameters remained comparable. Sensory difference testing indicated that consumers detected only minor attribute variations, and overall acceptability did not differ significantly between samples. The results demonstrate that okra pectin can function effectively as a chocolate emulsifier, producing milk chocolate with rheological, textural, and sensory characteristics comparable to those obtained with lecithin. These findings highlight okra pectin as a promising plant-based hydrocolloid for chocolate manufacturing, acceptable to consumers, offering both functional and allergen avoidance advantages.

Keywords: Chocolate, okra pectin, rheology

014 Strengthening Participatory Approaches for Expanding and Deepening Learning about Farmer Preferences: Insights from Farmer-Managed Seed Systems in Malawi

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Abstract

In subSaharan Africa, topdown outreach initiatives including extension demonstration gardens, on community land, working through community leaders, or with model farmers have not been effective approaches to increase adoption of improved varieties of neglected and underutilised crops in complex contexts where smallholder farmers' preferences are highly diverse. This study employed a Participatory Action Research (PAR) approach to map and identify farmer-preferred traits for Bambara nut and finger millet to understand how Malawian farmers' preferences and adoption to identify key varieties. The research was conducted over three rainfed agricultural seasons (2021-2023), engaged 150 farmers (57% female and 43% male) across five agro-ecological zones. Farmers evaluated 18 genotypes of the 2 crops at key growth stages (pre-planting, germination, vegetative and maturity). Panel data were collected using mixed methods that included individual interviews, focus group discussions, and observations of participants. We found that farmer varietal preferences exhibited spatial variability across geographic locations characterised by socio-economic and biophysical conditions. Moreover, these preferences were dynamic, shifting across seasons and crop growth stages, and inconsistently expressed between stated and actual choices of preferred Bambara groundnut and finger millet traits. These inconsistent patterns raise important questions about the effectiveness of farmercentreed breeding programs that rely on participatory methods to engage farmers in decisions about which neglected and underutilised crop varieties should be integrated into farmermanaged seed systems. There is a need to integrate PAR processes and principles into research and extension initiatives, despite the challenges the approach poses. The goals are to strengthen farmermanaged seed systems and improve access to quality farmerpreferred seed varieties of neglected and underutilised crop species in the diverse and complex contexts of subSaharan Africa. The presentation will share the challenges when using participatory variety selection with small holder farmers to identify key crop preferences.

Keywords: Neglected and Underutilised Species (NUS), Farmer-managed seed systems, Participatory Action Research, Bambara groundnut, Finger millet, Malawi.

015 Human Health Risk Assessment of Heavy Metals in Colocasia esculenta (L.) Cultivated in the Suame Light Industrial and Municipal Areas, Kumasi, Ghana

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Abstract

Peri-industrial farming in rapidly urbanising sub-Saharan African cities provides an important link between soil pollution and human health via food exposure pathways. This research offers a holistic view of potentially toxic element (PTE) contamination in soils and Colocasia esculenta (taro/cocoyam) in the Suame Light Industrial Area (SLIA, n = 21) and Suame Municipal Area (SMA, n = 15), Kumasi, Ghana. Soils and four tissues (root, corm, petiole, leaf) were analysed for arsenic, cadmium, chromium, copper, nickel, lead, zinc and manganese using portable X-ray fluorescence spectrometry (pXRF). Contamination Factor, Geo-accumulation Index, Enrichment Factor, and Potential Ecological Risk Index were employed to assess soil contamination. Bioconcentration and transfer factors were calculated for all metals and plant tissues. Positive Matrix Factorisation (PMF; US EPA PMF 5.0) was used for source apportionment, and supported by principal component analysis (PCA) and Pearson correlation analysis; spatial distribution was modelled using ordinary kriging in QGIS 3.34. Health risk assessment (HHRA) of dietary corm ingestion was conducted by the USEPA model for adults and children. SLIA soils had 25- to 80-fold elevated mean Pb and Zn concentrations (632 and 1212 mg/kg) above background and above Canadian Council of Ministers of the Environment (CCME) and the Dutch VROM limit values. PMF identified four sources: vehicle/battery sources (32%), metal processing and welding (28%), geogenic background (22%) and ubiquitous urban emissions (18%). Corm Pb concentration of 75.6 mg/kg dry weight exceeded EU/Codex Alimentarius standards by more than 200-fold. All metal Hazard Quotients exceeded 1, and carcinogenic risks for As, Cr, Cd, and Ni exceeded the 10^{-4} threshold by three to four orders of magnitude. These results demonstrate the serious risk of food-chain contamination from informal industry and the need for soil and crop quality standards, monitoring and phytoremediation strategies in urban peri-industrial food-bowls of West Africa.

016 Mechanisation and Gender Issues in Tiger Nut Production Systems in the Kwahu East District of Ghana

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Abstract

Tiger nut (*Cyperus esculentus* L.) is an important food crop grown in most sub-Saharan African countries, including Ghana. However, the harvesting of tiger nut, mostly done by women and children, is a major constraint on farmers. The majority of smallholder tiger nut farmers harvest using their bare hands and manual tools that are inefficient and labour-intensive. Manual tiger nut harvesting is painful, stressful, time-consuming, and full of drudgery. In Ghana, with the ageing agricultural labour force and the youth not attracted to manual work, labour charges are high, and not available during critical times. This adversely affects tiger nut production and processing. This study assesses the effects of mechanisation on labour substitution and gender issues in tiger nut production systems in the Kwahu East district of Ghana. A field survey was carried out in Aduamoah, a community known for commercial tiger nut production, to assess the availability and utilisation of agricultural mechanisation inputs and labour substitution among tiger nut farmers. Data were collected from 200 tiger nut farmers using structured questionnaires designed to elicit information on the utilisation of tools, machinery, labour, and gender issues in tiger nut production activities along the value chain.

The dataset included information on harvesting procedures, postharvest processing methods, farm management strategies, and demographics. Results show that 98% of tiger nut production relies heavily on manual labour, which contributes to production delays, high labour costs, and drudgery. Women constitute 81% of people involved in tiger nut farming. All farmers use hand tools (hoes) and 96 % use hired or family labour for harvesting, which requires 240 man-hours per acre. Manual harvesting of tiger nuts takes between two (2) weeks and three (3) months, depending on the acreage and availability of labour. Out of the 200 respondents, 90 % indicated loss or damage of tiger nut during harvesting as a major production constraint, while 87 % admitted the process is characterised by high labour cost. About 94 % of tiger nut farmers do not process nuts into finished products before selling. If available, about 88 % of respondents want to own a tiger nut harvester for their field operations. The key factors considered important for tiger nut harvester adoption include: ease of use (87%), efficiency in harvesting (98%), durability (93%), and affordability (96%). Despite farmers' strong desires, there is still a very low level of awareness and acceptance of mechanical harvesting techniques. This requires introducing, demonstrating, and adopting mechanical innovations. Mechanisation presents a viable pathway for labour substitution, productivity enhancement, and improved gender outcomes by reducing drudgery in harvesting and post-harvest operations. The development and adoption of a mechanical tiger nut harvester is one solution proposed to break the drudgery bottleneck associated with manual harvesting. This will help relieve women and children from the associated pain and drudgery, and turn tiger nuts into an industrial crop in Ghana.

Keywords: tiger nut, harvesting, drudgery, ageing labour force

017 Targeting Bakery Products for Dysphagia, Sarcopenia and Protein Malnutrition Management in Older Adults: A Systematic Review

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Abstract

Bakery products including bread, cookies, biscuits and cake are commonly consumed staples across the life course. They can therefore be targeted for enrichment with protein-rich ingredients which may enhance their textural properties and address age-related nutritional challenges such as dysphagia, sarcopenia, and protein malnutrition in older adults. This systematic review aimed to highlight current advances in the use of bakery products formulated with protein and texture-modulating ingredients as potential vehicles to deliver protein and address age-related nutritional challenges in older adults. A systematic search for relevant articles was conducted on the databases PubMed, Scopus, ScienceDirect and Cochrane Library up to October 01, 2025. Fourteen papers (n=14) investigated the ease of chew and swallow in older adults. The most frequently reported vehicle was bread (n=9). Commonly used ingredients for enrichment of the bakery products included soy protein isolate, whey protein isolate, soybean soluble polysaccharide, drum-dried pumpkin flour, inulin, sacha inchi seed cake and chicken protein powder. Most enriching ingredients were good sources of protein. Incorporation into the bakery products resulted in reduction of hardness and improved the subjective ease of chew and swallow. Enriching bread with protein-rich ingredients resulted in a significant increase in the protein intake of older adults. Recipe reformulation through controlled inclusion of protein isolates, hydrocolloids, vegetable flours, or dietary fibers, can enhance the nutritional value, improve the textural properties and ingestion of bakery products and could address protein malnutrition in older adults. Future studies should explore the use of other underutilised protein-rich ingredients for bakery product reformulation.

Keywords: age-related challenges; healthy aging strategies; texture-modified food.

018 Predicting aflatoxin contamination in white and yellow maize using Vis/NIR spectroscopy combined with PCA-LDA and PLSR models through aquaphotomics approaches

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Abstract

Prevailing analytical methodologies for aflatoxin detection are encumbered by labor-intensive sample preparation protocols and protracted turnaround times, underscoring the imperative for rapid, non-destructive alternatives. This investigation sought to develop and validate Visible/Near-Infrared (Vis/NIR) spectroscopy-based chemometric models for the classification and quantitative prediction of aflatoxin contamination at discrete concentrations (0, 3, 5, 10, 20, 30, and 50 ng/g) across three experimentally distinct datasets: naturally contaminated white maize (NWM), artificially spiked white maize (AWM), and artificially spiked yellow maize (AYM). Indigenous Ghanaian maize cultivars ("Omankwa" and "Abonten") were sourced from a certified outgrower in Ejura, Ashanti Region, Ghana. Natural contamination was achieved through controlled incubation in ***Aspergillus*** spp.-positive jute storage sacks, while artificial inoculation employed a certified total aflatoxin standard; all contamination levels were independently verified by high-performance liquid chromatography (HPLC). Diffuse reflectance spectra were acquired over the 400–2500 nm range using an XDS RapidContent Analyzer, with three targeted sub-ranges evaluated: 450–1050 nm, 1150–2400 nm, and 1300–1600 nm. Discriminant classification was performed via Principal Component Analysis–Linear Discriminant Analysis (PCA-LDA), while quantitative modeling employed Partial Least Squares Regression (PLSR). Aquaphotomics-based analysis was additionally conducted to elucidate water matrix coordinates (WAMACs) perturbed by aflatoxin presence. Characteristic absorption features at 500, 950, 1000, 1300, 1500, 1900, 2100, and 2300 nm were identified and attributed to protein, starch, lipid, and carbohydrate molecular moieties intrinsic to the maize matrix. Across the combined dataset, peak classification accuracies of 92.52% and 92.54% were achieved at 450–1050 nm and 1150–2400 nm, respectively, employing Savitzky-Golay first-derivative smoothing (filter width 17), with sensitivity, precision, specificity, and F1 scores approaching unity. Dataset-specific models (NWM, AWM, AYM) attained perfect classification accuracy (100%) across all wavelength ranges without exception. The optimal PLSR model, constructed for naturally contaminated white maize

in the 450–1050 nm range, demonstrated exceptional predictive fidelity: R^2CV = 0.99, RMSECV = 1.70 ng/g, RPD = 9.90, LOD = 0.60 ng/g, and LOQ = 1.81 ng/g — performance metrics comfortably exceeding both European Union (10 ng/g) and USFDA (20 ng/g) regulatory thresholds. Aquagram visualisation further identified biologically meaningful WAMACs at 1342, 1412, 1452, 1488, and 1512 nm, corroborating aflatoxin-induced perturbations in the hydrogen-bonding architecture of the maize water matrix. Collectively, these findings establish Vis/NIR spectroscopy, augmented by advanced chemometric and aquaphotomics frameworks, as a scientifically rigorous and practically viable platform for real-time aflatoxin surveillance across the maize supply chain. The technique holds strong potential for on-site, real-time monitoring and digitalisation of aflatoxin management across the maize supply chain.

019 Valorisation of Okra for Multifunctional Industrial Applications

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Abstract

Okra (*Abelmoschus esculentus*) is a multipurpose, climate-resilient crop native to Africa with great potential for promoting sustainable food systems through full-scale valorisation. Valorisation refers to transforming okra and its by-products—traditionally underutilised or discarded—into higher-value products across food, health, and industrial sectors. This study reviews the composition and multifunctional applications of okra's various parts, including pods, seeds, stems, and mucilage, highlighting opportunities to convert agricultural residues into value-added products. Despite okra's rich nutritional and functional properties, significant biomass losses occur during processing and harvest peaks. Integrating okra valorisation aligns with Sustainable Development Goal 12 (Responsible Consumption and Production) by fostering circular, low-waste, resource-efficient value chains that enhance local industry competitiveness, reduce dependence on imports, and support food and nutrition security. Promising valorisation strategies include the extraction and use of okra seed oil, pectin, and mucilage for applications in food formulation, pharmaceuticals, packaging, and bioenergy production. Recent studies show that certain okra genotypes yield up to 11–20% pectin, suitable for use as emulsifiers in confectionery and as disintegrants in pharmaceutical formulations. Addressing existing gaps in extraction technologies, process optimisation, and industrial scalability requires interdisciplinary collaboration to unlock okra's full potential as a sustainable bioresource.

Keywords: okra valorisation, pectin, mucilage, extraction, sustainable applications

020 Physicochemical, phytochemical and sensory evaluation of hibiscus-based tea bag formulation

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Abstract

Tea is one of the most consumed beverages globally, and there is a growing trend towards developing health-oriented varieties that incorporate functional ingredients. This study focused on the physicochemical, phytochemical and sensory evaluation of a Beetroot-Hibiscus tea bag, combining the antioxidant-rich properties of beetroot (Beta vulgaris) with the flavour-enhancing attributes of Hibiscus sabdariffa. Additional ingredients like ginger, date fruit, negro pepper, Guinea cubeb, and pineapple were incorporated to optimise both the health benefits and sensory appeal. Analyses were conducted to evaluate parameters such as moisture, pH, total phenolics, flavonoids, and antioxidant activity. The pH of the tea samples ranged from 2.01 to 2.53, with significant differences observed across formulations. Antioxidant activity ranged from 21.67% to 71.77%. The total phenolics content ranged from 457.5 mg/100g to 1286.94 mg/100g, while flavonoid levels varied from 23.55 mg/g to 39.33 mg/g. Sensory evaluations revealed that the addition of beetroot and other spices enhanced the overall acceptability of the product. The control sample had the highest antioxidant and phenolics content and this was as a result of the influence of its pH. The control sample had the least antioxidant property due to lack of the other additional ingredients. The results demonstrate that the Beetroot-Hibiscus tea blend is a promising health beverage, providing notable antioxidant benefits. The study highlights the potential for enhancing the health profile of tea with natural additives without compromising on sensory qualities.

Keywords: Beetroot, Hibiscus, Antioxidant activity, Herbal tea, Functional beverages

021 From potential to productivity: a climate-resilient rice system for sustainable food security in the Odaho inland valley, Ghana

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Abstract

Inland valleys are critical agro-ecological areas in Ghana, offering high potential for sustainable food systems, yet this potential remains underutilised. The study assessed soil–crop–climate interactions in the Odaho inland valley to evaluate its suitability for climate-resilient rice production. Soil physicochemical properties were analyzed alongside the performance of two rice varieties (Agya Pa and Agra), while historical climate trends (1994-2025) were evaluated using the Mann-Kendall test. The analysis showed sandy clay loam (SCL) soil with a mean bulk density of 1.42 g/cm^3, which does not restrict root development. The soil is classified as an Nta series (Eutric Gleysols), which has a high water-holding capacity, making it suitable for rice cultivation. However, constraints such as low nutrient levels and poor water control were identified. Rice production in the valley is mainly rainfed, with yields of both Agya Pa and Agra below the average of 3.20 MT/ha and the attainable potential of 6.00 MT/ha due to poor agronomic practices. Climate analysis revealed a non-significant increase in annual rainfall (τ = 0.14, p = 0.28), but a statistically significant rise in both maximum and minimum temperatures (τ = 0.55 and 0.52, respectively; p < 0.05), indicating increasing thermal stress on rice production. This study provides a baseline characterisation of soil, crop, and climate interactions in the Odaho inland valley to support climate-resilient rice intensification. While the valley has high potential for rice production, these findings underscore the need for integrated soil fertility management, improved water control, and climate-adaptive crop practices to enhance productivity amid increasing climatic variability.

POSTER – ECOSYSTEM

001 Explaining Sustainability in Ghana's Public Sector: The Influence of Politics and External Pressures

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Abstract

This study examines how domestic political dynamics and external institutional pressures shape the construction, prioritisation, and reporting of sustainability in Ghana's public sector, focusing on the localisation of the Sustainable Development Goals (SDGs) within national budgeting systems. The study employs a qualitative content analysis of Ghana's SDG budget reports and national budget statements (2018–2023). SDG-related budget allocations are extracted, classified into four sustainability dimensions (economic, social, environmental, and governance), and analysed using a sustainability priority index. Quantitative allocation trends are complemented by qualitative analysis of policy narratives to identify political and institutional drivers. Sustainability priorities in Ghana are highly volatile and politically contingent rather than stable or balanced. Social sustainability dominated in 2018 (54.98%), governance sustainability prevailed during 2019–2021 (70–79%), and fiscal/economic sustainability surged dramatically in 2022–2023 (66.29%) in response to fiscal crisis and IMF negotiations. Environmental sustainability remains persistently marginalised, never exceeding 4.22% of total allocations across the six-year period. Budgetary allocations are shaped by electoral cycles, donor conditionalities, global shocks (COVID-19, Russia-Ukraine war), and fiscal constraints, demonstrating that sustainability reporting is a politically embedded governance process rather than a neutral technical exercise.This study advances public sector sustainability accounting literature by theorising sustainability reporting as a politically constructed process. It introduces the concept of ***idiosyncratic conditionalities*** to explain how global sustainability frameworks are selectively adapted through the interplay of domestic political imperatives (electoral cycles, legitimacy concerns), fiscal realities (debt, IMF conditionalities), and external dependencies (donor funding, global shocks). The study provides empirical evidence from an under-researched African context, challenging assumptions of uniform SDG adoption.Findings from this study holds practical implications. Policymakers should strengthen environmental integration within budgeting systems, improve alignment between sustainability reporting and actual budget execution, and enhance transparency to support public accountability. Sustainability reporting must be recognised as a strategic governance and political communication tool, not merely a compliance requirement.

002 Tracing toxic legacies: Profiling the presence of flame retardants at Asawasi and Dagomba line informal e-waste recycling sites in Kumasi

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Abstract

Safe, clean water is essential for human wellbeing and development, making water security a critical global concern. Ensuring the safety of water sources for current and future generations requires rigorous monitoring of both established and emerging contaminants. The increasing use of electronics and electrical equipment (EEEs) has intensified the burden on waste streams, resulting in higher e-waste generation and the subsequent release of associated chemicals into the environment. This issue is compounded by the fact that over 90% of e-waste recycling occurs through informal practices such as manual dismantling, open burning, and acid leaching, which release hazardous substances, including flame retardants (FRs) and heavy metals, both of which are common components of electronic equipment. The present study examines the presence and distribution of five predominant brominated and organophosphate flame retardants, namely, Tetrabromobisphenol A (TBBPA), Decabromodiphenyl Ethane (DBDPE), Decabromodiphenyl ether (BDE-209), Triphenyl phosphate (TPP), and Tris(2-chloroethyl) phosphate (TCEP), at two informal e-waste recycling sites in the greater Kumasi districts of Ghana. The two study sites were identified through interviews with e- waste dealers, as the industry lacks formal collection and storage infrastructure. A GIS-assisted stratified sampling approach was then employed to obtain a representative profile of the sites. Twenty-one soil samples were collected across three distinct activity strata: open-burning, dismantling, and housing units. Samples were obtained from both surface (0–5 cm) and subsurface (5–30 cm) depths using sterilised tools to assess the vertical migration of contaminants. This approach is novel, as most previous studies at e-waste sites have focused solely on surface soils and have used smaller sample sizes, typically fewer than ten samples. The samples were air-dried to a constant weight and sieved for uniformity before storage for quantification. Contaminant extraction was performed using the Soxhlet method with a mixture of petroleum ether and acetone to extract both polar and nonpolar components. Quantification was conducted using an Agilent HPLC-UV system equipped with an ODS Hypersil reverse-phase C18 column. Quality control measures included duplicate analyses, blank controls, and instrument validation with reference standards to ensure data integrity. Preliminary results from physicochemical soil studies indicate moisture contents ranging from 1.13% to 17.45%, suggesting permeable soil conditions that may facilitate the leaching of FRs into the water table and hence serve as a major threat to water security as well as a public health concern since informal settlements are present in the chosen study sites. Ultimately, this research seeks to provide the empirical data necessary to support sustainable e-waste management policies and strengthen environmental protection in Ghana.

003 Peri-urban growth and the WEFE nexus: Land, food and ecosystem pressures in Greater Lomé and Yaoundé

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Abstract

Rapid peri-urban expansion in Sub-Saharan Africa is intensifying pressures on land resources, agricultural systems and urban ecosystems, raising critical challenges for sustainable development. Despite its rapid expansion, peri-urban growth in African cities remains poorly regulated and insufficiently understood in terms of its impacts on resource sustainability. This study analyses the spatio-temporal dynamics of land-use change in Greater Lomé (Togo) and Yaoundé (Cameroon) between 1988 and 2024, with a focus on implications for the land–food–ecosystem nexus. Based on multi-temporal Landsat imagery and supervised classification, the study combines land-use change detection with indicators of land-use efficiency and spatial patterns of urban form (density and fragmentation). The results reveal contrasted but converging trajectories of urban expansion. In Greater Lomé, built-up areas increased by +315%, accompanied by a sharp decline in agricultural land (−62%) and green spaces (−71%), reflecting increasing pressure on food systems, ecosystems and, more broadly, environmental resources, including water. In Yaoundé, urban growth is more moderate (+98%), with comparatively lower losses of agricultural land (−16%) and green spaces (−51%), indicating a more constrained but still significant environmental transformation. The combined analysis highlights differentiated modes of peri-urbanisation. Greater Lomé exhibits an extensive and spatially fragmented expansion, associated with inefficient land use and increased ecosystem degradation. In contrast, Yaoundé displays a more constrained and progressively densifying urban structure, suggesting relatively better land-use efficiency despite ongoing environmental pressures. These findings demonstrate that peri-urban growth in both cities is largely driven by land-consuming dynamics that weaken the resilience of food systems and ecosystems. The study contributes to the WEFE nexus by empirically demonstrating how peri-urban expansion reshapes agricultural land systems and ecosystem sustainability. It highlights the need for integrated spatial planning approaches that better regulate land expansion and preserve critical ecological and agricultural resources.

004 A Gender-Responsive WEFE Nexus Framework for Methane Mitigation in Smallholder Livestock Systems: The Role of Micro-Livestock in Sub-Saharan Africa

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Abstract

The methane mitigation strategy imposed on smallholder farming systems remains technologically biased, as a result largely ignoring the realities on the ground. This study argues for a paradigm shift that integrates gender dynamics in the WEFE nexus framework that exploits indigenous knowledge and promotes the utilisation of micro livestock as a low-emission livestock class and climate-resilient avenue for sustainable smallholder livestock systems in sub-Saharan Africa. Smallholder livestock systems that manage most of the livestock population are a major source of methane emission yet ignored on the global greenhouse gas emission mitigation drive. The current approach on methane mitigation often focuses on productivity gains and innovations while undermining the interconnected resource dynamics and communities' sociocultural circumstances that influence methane-emission channels in smallholder livestock farming systems. This study advances an overlooked avenue of gender-responsive and micro livestock integration in WEFE nexus framework for methane mitigation and sustainable smallholder livestock systems. The paradigm shift to this framework is the strategic inclusion of micro-livestock, such as poultry, rabbits, and small ruminants, which are predominantly managed by women but are largely neglected in climate policy and methane mitigation research. This study demonstrates how gender roles within micro-livestock farming systems contribute to reduced emission intensities, improved resource-use efficiency, and greater support of livestock-based livelihood opportunities. The WEFE nexus framework focuses on resource-use synergies, such as reduced feed and water competition, improved nutrient recycling, and minimised energy inputs, relative to conventional livestock systems. The proposed gender-responsive WEFE nexus approach highlights the role of women's indigenous knowledge, decision-making power, and access to resources in influencing climate-smart smallholder livestock practices and methane-emission outcomes. This proposal presents a gender-responsive and micro-livestock integrated conceptual framework as a pathway to improve resource utilisation in methane mitigation and smallholder livestock system resilience. It further describes how institutional support, gender-sensitive policies, and technological factors can support the integration of the WEFE nexus. This involves the provision of inclusive extension services, implementation of climate-smart breeding strategies, and development of targeted financial support for smallholder farming systems for methane mitigation and resilience. By strengthening gender roles within micro-livestock farming systems through the WEFE nexus framework, this study presents a practical pathway towards low methane emissions, greater climate resilience, and gender-inclusive livestock systems in sub-Saharan Africa (SSA)

Keywords: WEFE Nexus, Methane Mitigation, Micro-Livestock Systems, Gender-Responsive Agriculture, Smallholder Livestock Systems, Sub-Saharan Africa

005 Critical review of soil–water–energy dynamics in tillage operations: Implications for energy efficiency and mechanised farming in Nigeria

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Abstract

Soil tillage, defined as the mechanical manipulation of soil to create favourable conditions for crop establishment and growth, is a fundamental operation in mechanised agriculture with important implications for productivity and sustainability. This study presents a critical review of the interactions among soil, water, and energy dynamics in tillage operations, and their implications for energy efficiency and mechanised farming in Nigeria. The review draws on over 100 peer-reviewed and grey literature sources published between 2006 and 2026, using a systematic review approach combined with thematic analysis to synthesise current knowledge on the evolution, performance, and impacts of tillage systems in Nigerian agriculture. Findings show that well-designed tillage practices improve key soil physical and hydraulic properties, including soil structure, porosity, moisture retention, infiltration capacity, organic matter dynamics, and nutrient availability. These improvements enhance crop performance, reduce draught requirements and fuel consumption, and increase the overall operational efficiency of field machinery. Optimised tillage systems promote favourable soil tilth, supporting root development, water movement, and nutrient uptake, which are essential for improved crop growth and yield. The review further indicates that soil draught characteristics are major determinants of energy demand in mechanised farming systems. Within the water–energy–food (WEF) nexus framework, effective tillage management can improve water-use efficiency, reduce energy intensity, and increase agricultural productivity. The study also identifies a critical gap in integrated, context-specific analyses and provides a comprehensive synthesis of soil–water–energy interactions in tillage systems within the Nigerian context. The study concludes that optimising tillage practices is essential for achieving energy-efficient and sustainable mechanised agriculture, and recommends that stakeholders in Nigeria adopt appropriate tillage technologies, improve machinery selection, and implement targeted capacity development programmes.

006 Agroforestry for ecosystem resilience and sustainable land productivity in the Guinea and Sudan Savanna zones of Ghana: A scoping review

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Abstract

Agroforestry is a critical land-use system that supports rural livelihoods, ecosystem resilience, and sustainable agricultural production in the Guinea and Sudan Savanna agroecological zones of Ghana. By integrating trees, crops, and livestock within the same landscape, agroforestry systems provide ecological and socioeconomic benefits such as biodiversity conservation, soil fertility improvement, carbon sequestration, climate regulation, and livelihood diversification. Despite these contributions, agroforestry practices among smallholder farmers remain constrained by institutional, financial, environmental, and sociocultural factors. This study synthesises existing evidence to better understand the agroforestry systems practiced in northern Ghana, the ecosystem services they provide, and the barriers to their adoption and implementation. A PRISMA-guided scoping review methodology was employed to systematically identify, screen, and analyze peer-reviewed studies conducted within the Guinea and Sudan Savanna zones of Ghana. Relevant studies were selected based on predefined criteria, and data were synthesised to identify dominant agroforestry systems, commonly used tree species, ecosystem services, and the socioeconomic and institutional factors influencing agroforestry implementation. The review identified several dominant agroforestry systems widely practiced across the study area, including agrosilvopastoral, silvopastoral, and agrisilvicultural systems. Frequently reported tree species included *Vitellaria paradoxa* (Shea), *Parkia biglobosa* (African locust bean), *Faidherbia albida*, *Azadirachta indica* (Neem), *Mangifera indica* (Mango), and *Adansonia digitata* (Baobab). The ecosystem services provided by these agroforestry systems included carbon sequestration and climate regulation, biodiversity conservation, fodder provision, fuelwood and energy supply, soil and water conservation, and improved food and livelihood security for rural households. The review also revealed that, agroforestry adoption is strongly influenced by socioeconomic and institutional factors such as access to credit, irrigation support, land ownership and tenure insecurity, market access, extension services, and government support. Major barriers to implementation included financial constraints, climate variability, insecure land tenure, limited technical knowledge, and land degradation. This study contributes to existing knowledge by providing one of the few integrated syntheses of agroforestry systems, ecosystem services, and adoption dynamics across the Guinea and Sudan Savanna zones of Ghana. It bridges ecological and socioeconomic perspectives, offering a comprehensive understanding of how agroforestry supports sustainable land management, while identifying the structural constraints limiting its wider adoption. The review also highlights priority areas for policy intervention, institutional support, and future research aimed at scaling climate-resilient agroforestry practices in northern Ghana. Agroforestry systems play a vital role in enhancing environmental sustainability, food security, and rural livelihoods in Ghana's Guinea and Sudan Savanna zones. Although these systems provide

multiple ecological and socioeconomic benefits, their full potential is constrained by financial, institutional, and environmental challenges. Strengthening extension services, improving access to credit and markets, securing land tenure, and promoting supportive policies are essential for increasing agroforestry adoption and ensuring sustainable agricultural development in northern Ghana.

007 Gender–Indigenous Knowledge Intersections Driving Agroforestry–Livestock Systems for Climate Resilience in Smallholder Africa

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Abstract

Smallholder livestock systems are important for food security and livelihoods in rural economies of sub-Saharan Africa. This sector has been highly impacted by climate change through land degradation, feed and water scarcity and unpredictable rainfall patterns. The ability of livestock farmers to adapt to climate change is not solely a technology focused but a socio cultural and knowledge-based perspective. The present approach to livestock resilience has focused of technology often overlooking social structures and indigenous knowledge perspective. The paper identifies gender and indigenous knowledge systems intersections as an enabling factor in catalysing agroforestry -livestock systems for sustain climate resilience in smallholder livestock farming systems in Sub Saharan Africa. The study explores the gendered roles, access to resources, decision making and gendered indigenous knowledge on multi-functional ecosystems and ecological knowledge interact to influence gendered access to resources, decision-making power, and locally embedded ecological knowledge interact to influence the shaping of agroforestry practices that impart resilience and sustainability. Research has shown that these interplay influence agroforestry systems in terms of nutritional biomass, water and animal genetic resources in smallholder livestock systems as a result influencing gender equity and the effectiveness of climate adaptation strategies. Nonetheless abrogation of local knowledge and gender disparity such as gender bias resource allocation, restricted access to extension services and insecure land tenure poses as constraints to agroforestry-livestock systems for climate resilient in sub–Saharan Africa. The study proposes a gender responsive, indigenous knowledge inclusive conceptual framework to guide policy formulation, research management and practice with the view of a paradigm shift from technology-based solutions to community based agender that is rooted in a socio cultural and inclusive approach for agroforestry-based climate resilient in smallholder livestock systems in sub–Saharan Africa.

Keywords: gender, Indigenous Knowledge, Agroforestry, Smallholder Livestock Systems, Climate Resilient, Sub-Saharan Africa.

008 Breaking the Cycle: A Transdisciplinary Framework for the Climate-Food-Health Nexus to Safeguard Vulnerable Populations in Africa

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Abstract

The global food system is at a breaking point, with seven of the nine planetary boundaries already breached, signaling an urgent need for transformative action. Statistically, the problem is staggering: in 2024, approximately 673 million people (8.3% of the global population) faced hunger, with more than 295 million experiencing acute food insecurity across 53 countries. Regionally, the disparities are stark. While some areas show signs of recovery, Africa remains the epicentre of the crisis; the proportion of the population facing hunger in Africa surpassed 20% in 2024, affecting 307 million people. In East and Southern Africa alone, over 87 million people are struggling with hunger, driven by the sixth consecutive annual increase in acute food insecurity. This manifestation of the crisis is characterised by declining crop yields, increased frequency of extreme weather events like droughts and floods, and the erosion of economic reserves. If not addressed, these trends will lead to systemic collapse, where chronic malnutrition becomes irreversible, conflict over dwindling resources intensifies, and public health systems are overwhelmed by climate-sensitive diseases and stunting in children. The main aim of this abstract is to propose a transdisciplinary framework that integrates climate resilience, regenerative food systems, and public health outcomes to address these pressing challenges. Urgent attention is required for models that move beyond siloed policy-making, specifically focusing on nexus-based governance and community-led adaptation systems. The proposed methodology employs a mixed-methods approach, utilising stratified random sampling across diverse Agro-ecological zones to capture the unique vulnerabilities of women, refugees, and children**.** Data collection will involve remote sensing for climate mapping, longitudinal health surveys, and participatory food security assessments. To ensure robustness, data will be triangulated by cross-referencing satellite-derived environmental data with localised household surveys and clinical health records. Data collection will include quantitative and qualitative analysis using SPSS and NVivo software's. Decision-makers can utilise this integrated data to move from reactive crisis management to proactive, evidence-based policy. This approach directly addresses the shortfalls in achieving SDG 2 (Zero Hunger)**,** SDG 3 (Good Health and Well-being)**,** and SDG 13 (Climate Action) by identifying specific intervention points where climate adaptation and nutrition overlap. Furthermore, the integration of Artificial Intelligence (AI) and emerging technologies offers a revolutionary pathway to reduce malnutrition and food insecurity. AI-driven predictive analytics can provide early warnings for crop failures, optimise resource allocation for humanitarian aid, and personalise nutritional interventions for vulnerable groups. By leveraging machine learning to mitigate climate effects through precision agriculture and real-time monitoring, this framework provides a scalable solution to rebalance power, ensure equity, and build a resilient future for Africa's most marginalised populations.

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