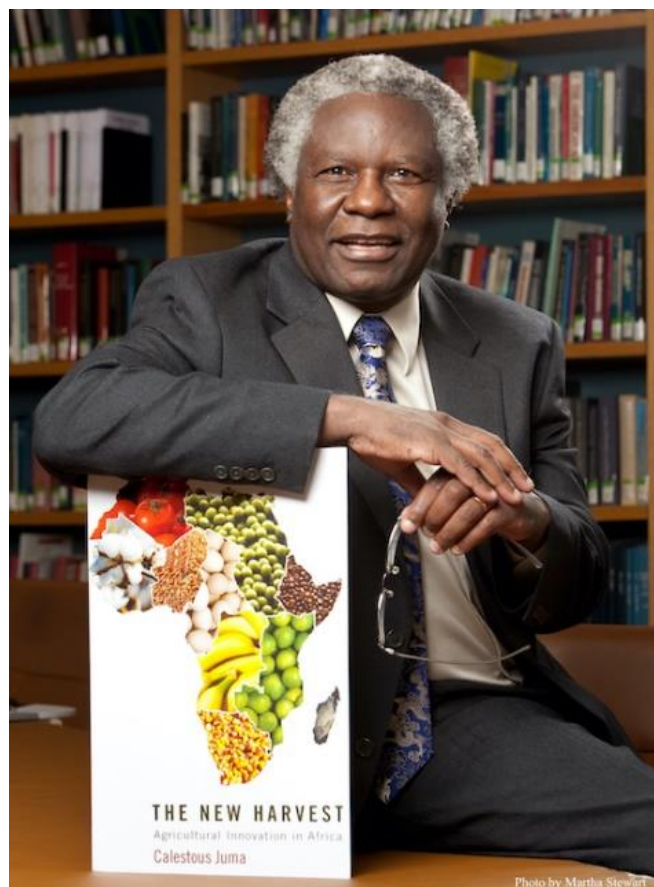


Proceedings

The 2nd Calestous Juma Seminar Series

Steering Science, Technology and Innovation to Achieve Sustainable Development Goals (SDGs)



29th – 30th November 2021

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List of Abbreviations

ACTS	African Centre for Technology Studies
CJ	Calestous Juma
CJLF	Calestous Juma Legacy Foundation
SDGs	Sustainable Development Goals
UNDP	United Nations Development Programme
AI	Artificial Intelligence
STEM	Science, Technology, Engineering and Mathematics
STI	Science, Technology and Innovation
MoU	Memorandum of Understanding
IUU	Illegal, Unregulated and Unreported
LVB	Lake Victoria Basin
MCS	Monitoring, Control and Surveillance
FGDs	Focus Group Discussions
MCM	Multi-criteria Mapping
KEMFRI	Kenya Marine & Fisheries Research Institute
IoT	Internet of Things
UK	United Kingdom
UNEP	United Nations Environmental Programme
NGO	Non-Governmental Organization
UN	United Nations
TFM	Technology Facilitation Mechanism
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNIATT	United Nations Interagency Task Team
GOSPIN	Global Observatory on Science, Technology and Innovation Policy Instruments
GDP	Gross Domestic Product
R&D	Research and Development
ICT	Information and Communications Technology
IMTA	Integrated Multi-trophic Aquaculture
IPCC	Intergovernmental Panel on Climate Change
NACOSTI	National Commission for Science, Technology and Innovation

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I. Executive Summary

The 2nd Calestous Juma Seminar Series themed '*Steering Science, Technology and Innovation (STI) to Achieve Sustainable Development Goals (SDGs)*' was held virtually on 29th-30th, November 2021. The seminar, which attracted more than 200 participants drawn from different parts of the globe, was jointly organized by the African Centre for Technology Studies (ACTS) and the Calestous Juma Legacy Foundation (CJLF). The seminar provided an ideal platform for experts to share their work and expertise with special focus on science, technology and innovation and how they are aligned with SDGs.

The first day featured insights from the Steering Research and Innovation for Global Goals (STRINGS) project, a global collaborative initiative led by the science policy research unit at Sussex University, whose key objective is to provide evidence and policy events and discussions to map, illustrate and better understand the alignments and misalignments between investments and priorities in STI and SDGs; and to get policy changes to improve STI and related investment towards SDGs. The presentation explored synergies between STIs and SDGs and how the former can be leveraged to achieve the latter especially in low income countries.

The second discussion item explored a case study on STI pathways to sustainable fisheries and aquaculture in Lake Victoria Basin (LVB). The case study focused on innovations (technological, institutional and social) to strengthen monitoring, control and surveillance (MCS) with a view to reducing illegal, unregulated and unreported (IUU) fishing and overfishing in the lake - cage culture pathway and pond fishing farming - two potential pathways to reduce pressure on inland capture fisheries. This was followed by an exciting panel discussion where experts explored technical issues relating to STI and their link to societal challenges. Key issues discussed included digitizing LVB fisheries for socio-economic inclusion, entrepreneurship through aquaculture, international research and capacity building priorities and innovation policies for sustainable aquaculture in LVB.

The second day featured a rich memoir of Prof. Juma, ably delivered by Prof, Norman Clark from the University of Sussex. It explored the journey of Prof. Juma from his humble beginnings in Western Kenya to a global icon for the application of science, technology and Innovation. His work focused on analyzing how knowledge and innovation could be harnessed for development in the context of institutional change in socio-economic systems. All his initiatives promoted this agenda through advance STI policy research provision of high level science technology advice and promotion of conservation of bio-diversity. He founded ACTS in 1988, where his initial developmental ideas were nurtured.

Prof. Juma's memoir paved way for a discussion on the global pilot program of STI for SDG roadmap, designed by the United Nations Interagency Task Team (UNIATT) whose main objective is align the SDGs with actions in STI. The pilot program kicked off with five pilot countries: Ethiopia, Ghana, India, Kenya and Serbia and later Ukraine. Key representatives of the three African countries – Kenya, Ghana and Ethiopia - provided updates with regard to STI for SDG roadmaps in their respective countries, mainly focusing on progress, challenges and opportunities. The final session of the seminar focused on steering agri-food system transformation and the role of STI. It featured innovations in marine fisheries and its potential for economic empowerment; community cooling hub – tapping into clean-energy solutions for reducing agricultural post-harvest loss in Africa; evidence for policy-making; and sustainability of food systems.

DAY 1

II. Welcome Remarks

Angela Christiana, Executive Director, Calestous Juma Legacy Foundation

Much appreciation to the African Centre for Technology Studies (ACTS) Governing Council and the secretariat for planning and organizing the 2nd Calestous Juma (CJ) seminar series and for the synergistic partnership between ACTS and the Calestous Juma legacy foundation (CJLF) in immortalizing Prof. Juma. This seminar provided a platform for experts to share their work and expertise with a special focus on science, technology and innovation and how they are aligned with SDGs, particularly with regard to sustainable fisheries and aquaculture in the Lake Victoria Basin. Part of the planned programming of the CJLF was to pursue practical development and capacity building related to the research on this topic. While CJLF is still in its early stages of organizational development, the foundation's mission is to advance economic transformation and sustainable development in Kenya and ultimately in Africa, more broadly through the use of science and technological innovation. The primary role of CJLF strategy is to help local communities develop and implement innovative solutions in health, educational, food security, environmental and employment challenges identified by local experts and community members with an initial geographic focus in Bunyala region, Prof. Juma's home area.

Prof. Juma believed that all human development ultimately takes place on the ground, in communities. The policies and investments he spent his life on were necessary, but unfortunately he run out of time to see similar development happen in his home area. During his last months, he defined his thoughts on local development in Bunyala region of Kenya. These reflected his beliefs in the power of innovation and technology, the core functions of a healthy environment and the urgent need for the empowerment of women and youth. He promised his community that he would not disappear into the wide world like so many before him; that their commitment to his education would not be wasted and CJLF intends to make good on his promise.

Prof. Tom Ogada, Executive Director, African Centre for Technology Studies (ACTS)

Prof. Juma's work was focused on the application of science, technology and innovation to sustainable development especially in developing countries. His work focused on analyzing how knowledge and innovation could be harnessed for development in the context of institutional change in socio-economic systems. All his initiatives promoted this agenda through advance STI policy research provision of high level science technology advice and promotion of conservation of bio-diversity. He founded ACTS in 1988, where his initial developmental ideas were nurtured. Today, ACTS has become today a leading inter-governmental STI think tank mandated to strengthen the capacity of African countries and institutions and harness STI for sustainable development. In pursuit of this mission, ACTS has been instrumental in enlarging the range of policy choices for sustainable development in Africa through high quality research, outreach and policy dialogues. For example, ACTS's work influenced industrial property legislation and policy in Kenya, environmental impact assessment standards in Eastern and Southern Africa and the formulation of bioenergy and biofuel policy in Eastern and West Africa.

The Role of ACTS

ACTS was the first to organize an international conference to discuss options that African countries could adopt to mitigate the impacts of climate change. It also played a major role in the negotiation for the convention on biodiversity. In his view, ACTS has remained true to Prof. Juma's original vision and attention on STI policy research and its application for sustainable development and the 7th strategic plan, which is being finalized, will focus on the core thematic areas that were always seen as the most important by Prof. Juma: agriculture and food security - the theme of today's seminar; climate change, energy, digital economy and the role of STI in addressing the challenges affecting these sectors. ACTS has strived to work very closely with the CJLF as a way of enhancing synergy in our efforts to build the foundation of CJ's legacy. The two organizations have signed an MOU to guide their collaboration

including the organization of the CJ seminar series. Finally, this second seminar series on steering STI to achieve Sustainable Development Goals (SDGs) with focus on agriculture and we have seen how important various aspects of agriculture are to the economic development of Africa including the issue of aquaculture, an area in which Prof. Juma was very enthusiastic especially on the use of STI for sustainable development, where ACTS draws its vision.

“Due to its excellent work, ACTS has earned top rating among environmental think tanks in Africa and in the world. For example in 2016, ACTS was rated amongst the top three most influential think tanks in climate change globally and number one in Africa. ACTS’ 6th strategic plan was dedicated to Prof. CJ as a way of laying the foundation for his immortalization” he said.

Finally, there will be series of follow up seminars for the next three years whose the topics will be around the work of Prof. Juma, and which will provide for at least one seminar every quarter; the next seminar will focus on digital economy.

III. Introduction to the STRING Project (UNDP)

Dr Tommaso Ciarli, SPRU, University of Sussex and STRINGS Project Coordinator/PI

The Steering Research and Innovation for Global Goals (STRINGS) project is closely connected with the legacy of Prof. Juma, who questioned how STI could address the challenges of those in need -mostly in Africa - if the sector focused on technological objectives rather than human challenges; and whether or not STIs increase inequality. These pertinent question led to the STRINGS project. Prof Juma believed that African countries could not sustain economic growth and promote prosperity without significant investment in technological innovation. And that African countries must reposition themselves as central players in the global economy rather than a recipient of knowledge. He simplified this concept in three steps: building of infrastructure, mainly digital infrastructure; enhancing innovation and knowledge sharing, technical competence and skills to improve Science, Technology, Engineering and Mathematical (STEM) education; and technology based entrepreneurship. He particularly emphasized the role science and technology such as biotech, nanotech and artificial intelligence (AI). Prof. Juma’s message focused on the strategic role of technological innovation in addressing critical challenges such as meeting human needs such as health, improving international competitiveness and protecting the environment. And the need to develop national research and innovation capabilities in countries in order to reduce the reliance on external resources and science and technology

The STRINGS Project

The STRINGS project arose from the observation that although science and technology solved many problems like those related to the SDGs, scientific advance is quite unevenly distributed with respect to society. This is because STI based solutions affect people positively and negatively in many different ways. And therefore, there are priorities and restraints. As a result, in most cases, those priorities often do not match the problems of those who are most in need and are less represented in the STI system. For example STI investment in health in relation to diseases are mainly relevant to the north and not the south. This was more pronounced in the development of Covid-19 vaccine which led to enormous inequity in terms of how the vaccine has been picked up and developed. There is a strong concern about aligning STI to the human challenges and goals. The SDGs are fundamental because the priorities were agreed amongst all countries after a long discussion. It is therefore imperative for researchers, public and private research funders, policy makers and society at large to study and shape the direction STI should take in order to progress towards sustainable SDGs, an opportunity which should not be missed to ensure STI contribute towards sustainable solutions in line with SDGs.

The main aim of the STRINGS project, which is a global collaborative initiative - led by the science policy research unit at Sussex University and other collaborators - is to provide evidence and policy events and discussions to map,

illustrate and better understand the alignments and misalignments between investments and priorities in STI and SDGs; and to get policy changes to improve STI and investment in STI towards SDGs. This combines analytical and policy effort to provide tools that can be used by different stakeholders to define the priorities in STI which may lead to identifying priorities in SDGs. It is implemented by the University of Sussex in collaboration with UNDP with an MOU between UNDP and UK Research and Innovation (UKRI). The project is also present in Netherlands, Argentina, India, South Africa and Kenya. There have engagements and discussions with different experts and communities across the globe to refine and revise emerging issues analysis and results as they arise.

Challenges

Whereas the STRINGS project strives to steer STI towards SDGs, the process has become extremely complex because the two entities are complex systems with lots of interactions that usually ends up not addressing the needs of the majority of the population. Thus, to achieve sustainable development, there is a need to steer this complex system taking into account its diversity and how people may prioritize different contexts and aspects. While SDGs provide different potential ways of investment and interpreting progress, STI can move in many different directions to address different aspects of sustainability in different ways. Thus, SDGs have different goals and targets and many different ways of implementing STI in different countries, regions and municipalities that face different sustainability problems. As a result, it is important to consider the multitude of the plurality of ways in which different forms of STI can address different aspects of sustainability.

So how did the STRINGS project address this complex challenge? By combining different levels of analysis, analytical angles, methods and disciplines and comparing those results across different levels of analysis to better understand the multiple phases of STI and how they are related to SDGs. It focused particularly at the economic level by mapping and visualizing the global data across time and countries in the past and how this has evolved; how and who has been prioritized and in which location. Projections were then done - looking at different constituencies and beyond - of those engaged in STI asking about their priorities in the future, how STI can address SDGs and what they would prioritize if they were to address SDGs. It focused on different pathways that are constituted, developed, reinforced or marginalized in order to address very specific challenges. The project is particular on how it addresses the challenges in the local context, the multiplicity of various pathways and how they can address SDGs.

In the global mapping, the project focuses on how research and innovation relate to SDGs, who does it, what it looks like and how it is different from research. This is done by examining secondary data on research innovation and mapping them into different research areas across all potential disciplines from health to life sciences, social sciences, mathematics and physics and engineering - all the disciplines that deal with science and technology. Specific areas of innovation were then examined and assessed based on the extent to which they related to different SDGs.

Meanwhile, experts were asked the relevant technologies that could address SDGs by 2030. Researchers were also interviewed on different stakeholders and how communities prioritize different STIs and what could be captured by publications. There were also case studies where, in Kenya, STI pathways were found in three different locations. In India, the project examined how climate resilience seeds are developed to address climate stresses and to make more productions to address hunger. In this case, the focus was on developing the rice seeds to address a number of challenges including poverty, hunger, health and drought for sustainability. In Argentina, the project focused on various forms of doing science to address endemic illnesses and how various types of open and closed science can address the SDG challenges in relation to poverty, health, gender, education and technological innovation. The third case study was done to understand how different pathway address conflict around over fishing in the Lake Victoria region in Kenya to overcome challenges like poverty, hunger, conflict, governance and life below water.

Key Findings

High income countries which dominate research agenda constitute 94% of research innovations and publications globally. Low income countries, mostly in Africa, focus more on SDGs but have minimal formal knowledge production in form of publications and patents. There are few opportunities for knowledge transfer and capacity building in low income countries especially related to research. And although there is substantial research mainly

focused on health, 60% of it is aligned to SDGs, mainly related diseases relevant to the north and not in the low income countries. There are minimal efforts to address the complex underlying societal issues related to politics and conflict as opposed to research leading to technological solutions.

A number of synergies exist between research and SDGs which should be explored to better understand the trade options among the different institutes. SDG related research, especially on social and societal challenges, is more multi-disciplinary and more likely to be used in policy and is highly rated by standard academic methods. However, it is not particularly well funded. It was found that countries with challenges relating to poverty, hunger, health, clean water and sanitation tend to do more research on these SDGs as opposed to developed counties which focus on issues related to climate.

It also emerged that that future priorities do not align with past research development and innovations which has been predominantly STI. Priority areas addressing the SDGs include policy and social innovations. However, in order to align STI to SDGs, it is important to consider the different ways, directions and pathways that can be developed in STI in addressing the SDGs. People have different needs, which leads to different STI pathways with different ways of addressing SDGs, which are often relevant in different ways. For example, development of rice seeds factors in economic fundamentals, nutrition, accessibility and plant resistance: different stakeholders have different views about how one pathway works better for one or other targets. In this sense, therefore, there is need to nurture the plurality.

Key Recommendations

Based on the findings, it is recommended to build on the richness of the diverse way of delivering on STI. And according to Prof. Juma, *'there are so many things that can make us positive about the future and one of them is people talking about solutions'*. Therefore, it is important to nurture different people, ideas and ways of looking at STI based on local and international governance for STI for sustainability that maintains and encourages different trajectories and alternative ways of interpreting the different issues relating to STI. There is also need to question analytical findings from different perspectives and use them from different perspectives. The mappings are essential complemented by discussions about how different priorities may be encouraged in different contexts.

Also, it is important to have better global coordination of STI efforts, global understanding and steering. Given that most of the investment is concentrated in high income countries, it is important to we monitor these investment to make it more relevant for the SDGs. This will require global platforms that collect, use and discuss data among different stakeholders in order to better inform the decisions of policy makers around the globe about better funding. Thus, instead of having single funders that gain with policy makers, users can coordinate and define different priorities across different contexts. Finally, it is crucial to empower stakeholders to use open access data in order to influence potential actors in different areas in STI and SDGs.

Policy Actions

A key policy recommendation is to increase funding for SDG related research and innovation by involving a wider range of actors and increase diversity of views across different countries, focusing particularly on low income countries where research is more related to the SDGs and prioritizing international collaborative research which is done in a much more equitable way. Meanwhile, it is important to prioritize underlying social issues instead of simply looking at technological fixes, particularly in relation to social innovations and informal research. This requires focus on STI areas related to different SDGs in terms of discipline, challenge and interaction and focus on inter and transdisciplinary research and different approaches of the outcome of STI, not just excellence but also impact, learning and usefulness in the context of SDGs.

In addition, it would be prudent to revise the priorities in STI portfolios because they are not well aligned with the SDGs. Combining excellence with the need to address the challenges, with a premium on research that addresses local challenges rather than publishing in academic journals is crucial. Finally, it is imperative to capture and document specific innovations in different aspects because it is difficult to access STI interventions across the globe particularly in low income countries.

IV. STI Pathways to sustainable fisheries and aquaculture in Lake Victoria Basin

Prof John Ouma-Mugabe, GSTM, University of Pretoria (STRINGS SSA co-PI)

The choice of this case study was inspired by one of Prof. Juma's academic works before his demise. The first sections of his provocative paper at the Vatican Academy of Sciences titled '*Game over? Drivers of Biological Extinction in Africa*' was about extinction of fish species in Lake Victoria. The paper was published in a book by biodiversity scholars titled '*Biological Extinction: New perspectives*'. The paper argued that importing technologies and management practices into Lake Victoria and other African ecosystems cannot address problems of biodiversity degradation. According to Prof. Juma, many of the drivers of fish loss in Africa are unique to the continent and cannot be addressed by adopting lessons from other regions of the world.

Lake Victoria is the world's second largest fresh water lake, shared by at least three countries (Kenya, Tanzania and Uganda), therefore it is transboundary in nature. Its management is complex. The lake is home to at least 5000 endemic fish species. Before the 1950s, the lake fisheries were diverse in terms of fish and fishing practices. In 1954, there were some changes in the lake particularly with the introduction of the Nile perch by the colonial government, which resulted in extinction of native species of fish and the attendant ecological and technological changes in the lake region. In the 1980s and 1990s, there were efforts to industrialize fisheries in Lake Victoria to meet global demand for fish through exports to Europe and Asia. This led to a major decline in fish population in biodiversity. A study conducted by ACTS in 1998 showed that despite increased fish production, particularly the Nile perch, there was increased food scarcity in the region. In a video titled '*Big fish, small fry*' highlighted increased fish production for export but increasing food insecurity in the region. Competition for fish intensified with changes in fishing processes and increased industrial fishing which led to illegal, unregulated, unreported (IUU) fishing.

Therefore, this case study focuses on how to address the issues of illegal and overfishing in the lake which are major sources of conflict in fisheries, especially conflicts over fish and fishing gear. The case study explores possible plural innovation pathways out of overfishing, illegal, unregulated, unreported (IUU) fishing conflicts in the Lake Victoria Basin (LVB). It explores 3 innovation pathways:

- Innovations (technological, institutional and social) to strengthen Monitoring, Control and Surveillance (MCS) in order to reduce IUU fishing and overfishing in the lake;
- Cage culture pathway, and
- Pond fishing farming pathway' two potential pathways to reduce pressure on inland capture fisheries.

The study explores whether and how the three innovation pathways can be steered to achieve SDG 14 (effective regulation of overfishing and IUU fishing) and SDG16 (peace, justice and strong institutions) in the Kenyan LV Basin. It aims at informing the revision and implementation of Kenya's national policies for STI, fisheries (biodiversity in general) and aquaculture; and informing strengthening of the National Fisheries Management and Development Act No. 35 of 2016

Methodology

The case study applied a mix methodological approach as outlined below:

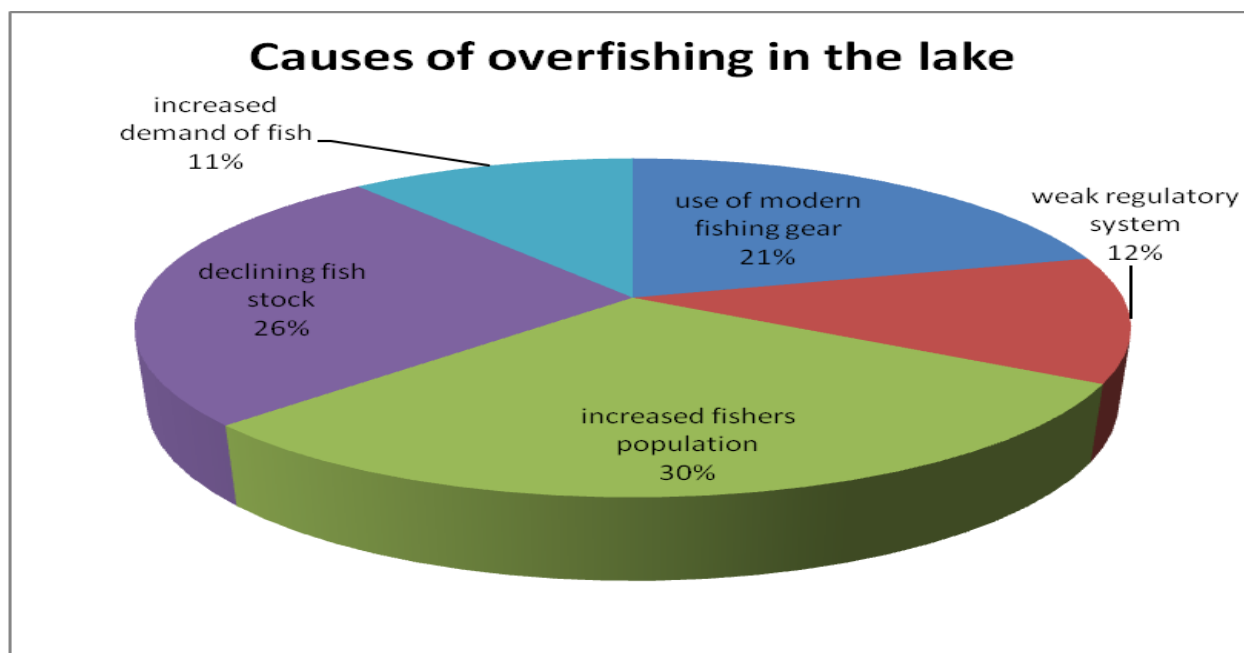
- Literature review to identify key issues in and causes of overfishing, IUU fishing and fisheries conflicts; map actors, etc and inform design of questionnaire
- Focus Group Discussions (FGDs)– 27 August 2020 at Marenga Beach, Port Victoria and 10 September 2020 at Bumbe Beach, Samia
- Questionnaire and interviews (January-June 2021)
- Multi-criteria Mapping (MCM) workshop and interviews (April 2021)

A. Findings from the Focus Group/Discussions

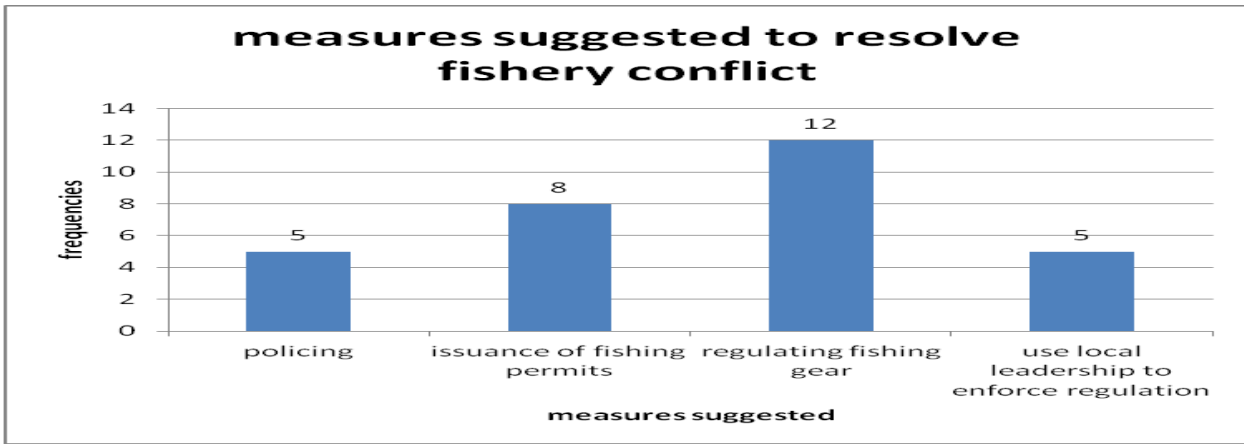
Mr. Paul Kombo, County Government of Busia (STRINGS SSA Researcher)

Majority 68.8% of participants at FGDs agreed that overfishing and IUU fishing exist in LVB, while the remaining 31.2% disagreed that there is overfishing/IUU fishing in the LVB. Causes attributed to overfishing and IUU fishing as well as conflicts include:

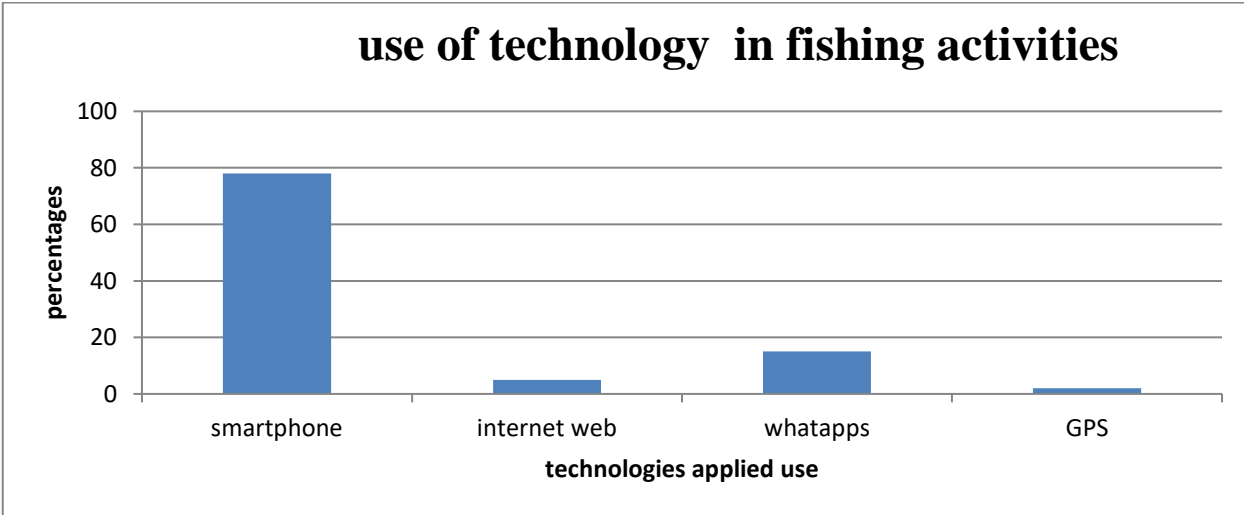
- decline of fish stock
- use of illegal fish gear
- increased fishers population
- Technological development



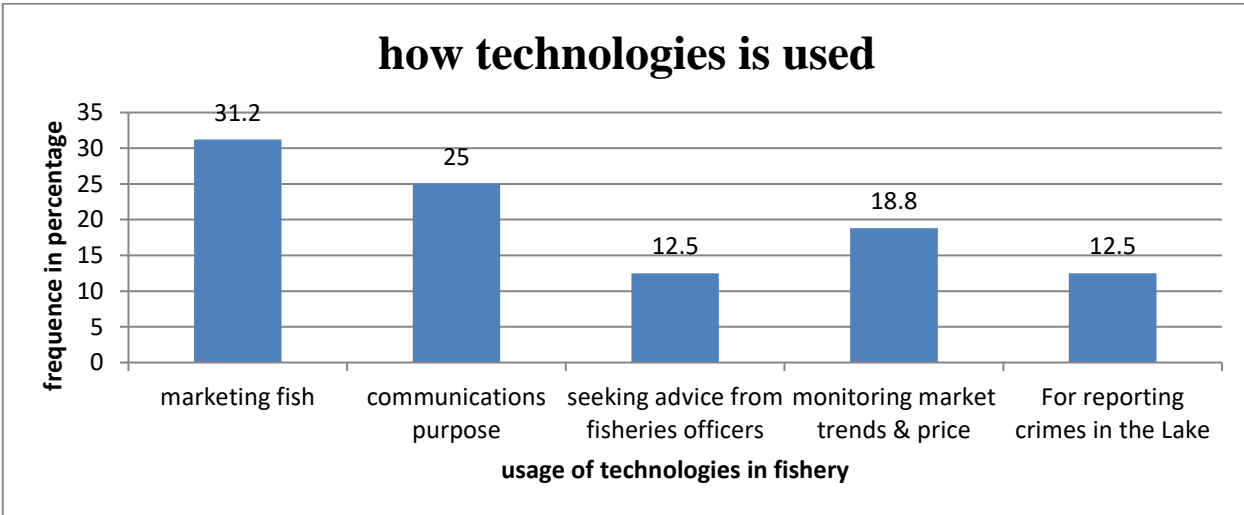
Causes of overfishing in the lake



Measures suggested to resolve fishery conflict



Use of technology in fishing activities



How technologies is used

B. Multi-criteria Mapping (MCM)

Nora Ndege, Research Fellow, ACTS

This is Hybrid quantitative / qualitative method, linking less tangible qualitative conditions with generally more visible quantitative assessments. It ‘Broadens out’ scope of appraisal beyond usual confines and ‘opens up’ a picture of ‘plural and conditional’ patterns and retains a concrete focus on practical options for action. It also ‘opens up’ a

map of different views and rigorously explore how ‘answers’ depend on different ‘framings’ of questions (not ‘closing down’ to a single view). It is for evenly illuminating the pros and cons of alternative pathways.

MCM workshop in Ugunja

The workshop brought together different stakeholders as outlined below:

- Aquaculturalists
- Local community members
- Academics
- Local government representatives

Different stakeholders appraised the MCM pathways and whose views are summarised below:

Researchers

- Monitoring, control and surveillance (MCS) pathway performing worse than the other two pathways;
- MCS lacks appropriate resource allocation by county and national governments and even when they do so, there is lack of stakeholder contribution to their work.

Aquaculturalists

- MCS rated lowest. Seen as a vehicle for advancing corruption;
- cage culture performs better;
- Aquaculture pathways (pond and cage) appraised as somewhat better performing than MCS.

Local Community

- Pond culture score is associated with a lower uncertainty than the other two pathways;
- High uncertainty associated with the MCS pathway;
- MCS pathway as the best performing;
- Low scores for pond as quality of the fish deemed inferior.

Local Government

- MCS may curb illegal fishing, increasing size and quality of fish capture, fetching higher prices (optimistic scenario);
- Ponds may support increased production but constrained by availability of land and fish feeds (pessimistic scenario).

Findings from questionnaire & interviews

- Monitoring, Control and Surveillance (MCS) in Lake Victoria is characterized by reliance on a very narrow range of range technologies, weak regulatory governance, weak institutional coordination (particularly between BMUs and the Kenya Coast Guard), corruption and political interference;
- At least 65% of interviewees and respondents to the questionnaire do not consider it an efficient or adequate pathway out of overfishing and IUU fishing;
- Pond fish farming is considered by majority interviewees and respondents (80%) as a pathway with/of high potential to reduce fishing pressure of inland capture fisheries. Increasing number of local income households and women (and women groups) entering the pond fishing pathway;
- Major challenges in pond fishing farming are frequent floods, scarcity of quality fingerlings and fish feed, weak extension services from KFS (to help address veterinary issues), and ambiguous land tenure regimes. Pond fish farming is based on old technologies, less integrated in/with other economies activities in the region.

- Cage fish farming is the dominant aquaculture pathway, and considered by at least 80% of respondents to have high potential of reducing overfishing and IUU fishing as it attracting fishers from inland capture fisheries. However, costs of entry are relatively high for low income fishers. It is increasingly controlled by politicians and persons with connections to the county governments...

Emerging Issues

- MCS and fish farming (cage and pond) can evolve with potential to be *a mix of complimentary pathways to* SDG16, SDG 14 and contributing also to SDGs 2, 5 and 8;
- The MCS pathway needs to accompanied by strengthening of institutions, *address issues of corruption and enforcement, enhance involvement of BMUs and local communities;*
- Potential of cage and pond fishing as pathways to SDG16 depends on mobilizing and strengthening social institutions e.g. women groups and cooperatives;
- No evidence that current R&D initiatives (by KEMFRI and universities) and extension services are aligned, and are capable to supporting fish farming to reduce pressure off inland capture fisheries.

Recommendations

- MCM, pond fishing and cage fishing should be ‘deliberately steered’ as pathways to SDG14 and SDG16 (with potential for SDG2, SDG5 and SDG8) through a holistic innovation policy framework, with ‘policy mixes (and policy instruments) that encompass social, economic and ecological sustainability goals. Single (standalone) policies and/or policy frameworks will not deliver...
- Reconfiguration of current institutional arrangements to ensure and enhance robust articulation/synergies (e.g. between BMUs and KFS, private and public sectors) is need to establish a dynamic locally embedded Innovation System (IS), helping to create local sustainable fish production value chains;
- Strengthen governance instruments and structures, particularly in MCS and cage fish farming pathways, by enhancing the involvement of local people in policy design and programme implementation. National top-down policies, plan and programmes do not deliver innovation at local levels. Locally designed and embedded innovation policy and regulations needed;
- Invest in the use of county and national public procurement frameworks to prospect, procure and introduce modern aquaculture technologies and build capacity of local institutions to adapt and deploy modern technologies... in local social conditions.

v. Panel on steering STI for sustainable fish production in Lake Victoria Basin (LVB)

Moderator: Dr. Joanes Atela, Director, Communication and Impact, ACTS

This section featured discussions from panelists focusing on technical issues relating to STI and their link to societal problems or challenges alluded to in the previous session. It is important to reiterate that Prof. Juma believed in STI and how it could solve societal problems; and this is one of the areas that ACTS' is passionate about especially linking STI to societal challenges, and most importantly Agenda 2063 - about a knowledge based economy - and also to strengthen the achievement of sustainable growth.

Discussants in this section were:

- Dave Okechi (Fish farmer, Kisumu County) Digitizing LVB fisheries for socio-economic inclusion;
- Mr. Fred Juma, (Fisher farmer, Busia County) Entrepreneurism in fisheries and aquaculture;
- Prof. Les Kaufman, (Researcher, Boston University) International research and capacity building priorities
- Dr. Paul Orina (KFMRI) Innovation policies for sustainable aquaculture;
- Alison Field-Juma - (CJLF Vice President) Potential capacity building in LVB fisheries and aquaculture.

A. Digitizing LVB Fisheries for Socio-Economic Inclusion

Dave Oketch, CEO of Aqua Rech limited

Aqua Rech Limited uses technology and high quality inputs to enhance fish farmers' productivity, provide market access, promote equal trade and building fish farmers resilience to climate change. Technology essentially is supposed to promote equal opportunities for those who are excluded. Aqua Rech has a strong emphasis on using technology to reach out to select and excluded groups in the society. The company focuses on two types of technologies which are digital application based on Internet of Things (IOT). It enables farmers to practice precision fish farming and through that link the fish produced to farmers that directly to the fish traders who are women and youth who rely on fish as a means of livelihood.

The company is also developing contractual fish farming that will enable women and youth who do not have the financial might to buy this technology or acquire it on a lease-purchase agreement. So far, there has been some socio-economic and environmental impacts resulting from these technologies. Socially, there's gender empowerment, which means women and youth are able to comfortably access fish information at the comfort of their phones, promoting decent jobs and contributing towards elimination of vices that exist in the fisheries and aquaculture sector, such as sex for fish trade that is prevalent because of lack of information about alternative sources of fish.

In addition, through the implementation of the Aquarech app, there is increased revenue to fish farmers by up to 60%. This is because farmers within these areas can access the high quality and affordable fish feeds imported by the company and which has reduced their production period from 13 months to 8 months and increased productivity by 40%. Thus, more fish is available to the community and less cases of malnutrition because of less reliance on wild fish and more reliance on farmed fish farmed by digital aquaculture. Environmentally, this technology is contributing towards reduction of greenhouse gas emission. Digitizing aquaculture is leading towards reduction of greenhouse gas emission. Why? Because farmers are now getting access to floating pellets which are less detrimental to the ecosystem of the lake; their floating nature lead to less pollution of lakes and rivers. The company is also looking at deploying IoT technology to as many smallholder fish farmers as possible and deployment of artificial intelligence. The company is in the process of designing an AI software to enable smallholder fish farmers to count the number of fish they have, get the average grammage and identify diseases at an early stage and hopefully arrest the situation to make the sector more resilient against diseases and

changes in climatic conditions. So far AquaRech has managed to deploy IoT sensors which are supporting precision fish farming for the smallholder farmers in the Lake Victoria

B. Entrepreneurship through Aquaculture

Fred Juma, Hydro Victoria Fish Farm, Busia County

Aquaculture is a source of livelihood with good nutritional value. In Kenya, there is a fish deficit of about 500 tons annually which means that fish imports are increasing while the exports are declining. There are quite a number of business opportunities in aquaculture right from the time the young fish is hatched to value addition and the market. There are equally a number of challenges in aquaculture which calls for various innovations; some of the solutions are not readily available on the shelves to meet the food system demands i.e. economic, social well-being and environmental sustainability.

“Port Victoria in Busia County is blessed with lots of Tilapia and Nile Perch; and has been a major landing site in the 80s 90s up to the 2000s. Changes in the economic alignments in the region resulted in less fish, which proved to be a big challenge for the local fishers” said Juma.

Hydro Victoria Fish Farm positioned itself in a prime location on the shores of Lake Victoria to provide fish fingerlings, feed and support fish farmers or fishermen in the area. However, the cages currently being deployed are quite small and metallic and can be improved with the innovations and technology. The farm can access bigger cages which can hold as high as 18 tons in one production which presents opportunities and challenges. The farm supports over 2300 fish farmers in Western Kenya providing about 1.5 million fingerlings annually. The farmers face several challenges, key of which is the high cost of feed. As a result, the farm introduced a concept which focuses on integrating resources and the interaction with the community in a way that ensures environmental protection. They have set-up a black soldier fly farming and trained 40 groups on how to use black soldier insects to reduce the cost of feed. The farm is looking at innovations that can convert the waste that remains from the Black Soldier as manure for vegetable farming. The farm is also tapping into the power of technology by using taking advantage of internet access, solar powered lighting systems to security.

“We’re using technology which can be accessed by smartphones to be able to visualize your cage if you are in another city/town” he said.

The farm is also looking to establish the first organic fish feed plant in Kenya and have been supported by an inclusive grant by World Bank for the Kenyan Climate Smart project.

C. International Research and Capacity Building Priorities

Prof. Les Kaufman, (Researcher, Boston University)

Technology and science can transform and accelerate cage aquaculture and this has the potential to transform society. However, technology is just a tool to facilitate sharing of knowledge. This section focus on 4 key issues:

1. Advancing cage aquaculture;
2. Balancing cage aquaculture with wild capture fisheries;
3. Aquaculture in the context of ecosystem sustainability;
4. Training and capacity building.

There are several key entry points for technology which can be useful in advancing cage aquaculture. These include:

- Optimal sighting and planning which examines the limits of sustainable cage aquaculture – in Kenya, or in any one village or in the lake as a whole;
- The sudden explosion of cage aquaculture requires renewable energy to keep it going so as not to increase demand on wooden fossil fuels;

- **Watershed management:** the future of aquaculture is tied up with how well we manage the watershed. Are we preserving our swamps, which is particularly important in Siaya and Busia and Bunyala? This is because these swamps have the potential to clean the water before it gets to the lake. However, this function has been short-circuited, which means that polluted waters are going straight into the lake, often in areas that would be suitable for aquaculture.

Other important considerations for cage aquaculture include: digitization of cages, sustainable feedstocks that are plant or insect based instead of fish based, introducing native species to expand the market and diversity of offerings to local consumers, and contribute to species conservation. And finally, all of this depends upon rapid digital communications and broadly accessible broadband Internet.

Balancing wild and capture fisheries is partly about science, but it's mostly about communication. There is need for more lake wide monitoring to understanding how what's going on in Kenya is related to what's going on in the rest of the lake. Also, it is important to have regular commercial survey that look at limnology and biodiversity. Tech centers are also required in each country that integrate and share all of the data from remote sensing ground data from the cages in the lake and our science modeling and forecasting.

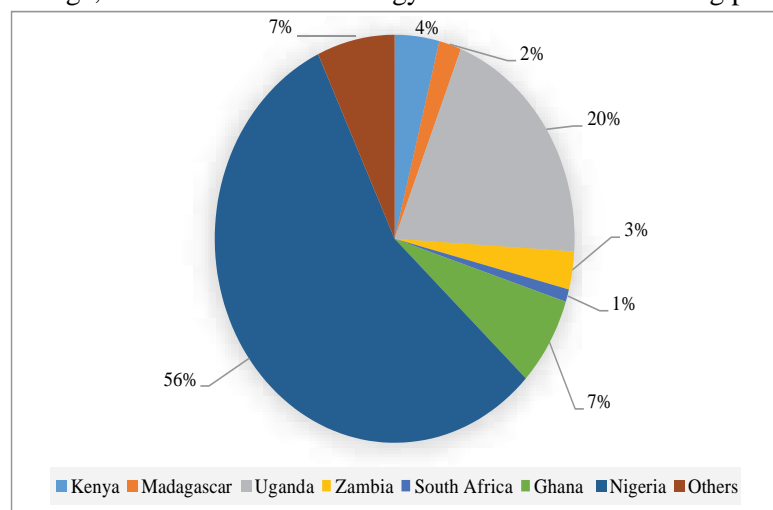
Meanwhile, it is crucial to have ecosystem based management that takes all of this into account indigenous species diversity. Other important factors are ensuring affordable proteins for the local markets while stabilizing export market stream, reintegrating the balkanized departments of the fisheries department in Kenya and connecting them more efficiently with the research on KMFRI with a common vision for ecosystem based management, improving joint science and practice. There is also need to leverage on area management and community based conservation to protect Lake Basin habitats and prevent importance species from going extinct.

Finally, training and capacity building is critical. It would be prudent to have a league of Lake Basin Angels who are young scientists and ecology, aquaculture, tech, sociology, anthropology and economics. They need to work together as an interdisciplinary team and ensure equal opportunities across genders, ethnicities and backgrounds. And finally, as part of the ecosystem approach, it is important to integrate the wildlife service, forestry, agriculture and urban planning with fisheries and fisheries research with a view to having a holistic context for aquaculture that fits national development plan and efforts to meet SDGS.

D. Innovation Policies for Sustainable Aquaculture

Dr. Paul Orina (KFMRI)

A lot of work has been done to support aquaculture in Kenya and the government has put quite a lot of resources. The private sector has also contributed significantly. As illustrated in the figure below, Nigeria is leading the pack in Africa while Kenya is not doing so well, which is a concern. For this reason, there is need to focus on issues of climate change, innovation and technology with a view to enhancing productivity.



Feed Production

One of the key areas of focus is improvement of feed. KMFRI Sangoro is leading on the bio-floc technology and use of fertilizer for mass production of bacterial and other zooplankton for fish larval rearing. This has significantly lowered larval mortality of catfish and enhanced survival and quality of tilapia fingerlings

“We hope that in this direction we shall have a much stronger feed, fast grower feed and more resilient to challenges but of course increasing incomes in the value chain actors and the government is leading this with the private sector: said Orina.

There is also the integration of indigenous species. KMFRI Kegati Centre is at advanced levels of introduction to aquaculture of indigenous species with high commercial value. This include Tilapia Baringo, Jipe Tilapia and African carps (*Labeo* and *Barbus*). *Labeo victorinus*, Tilapia Baringo and Tilapia jipe are already domesticated with culture growth and survival against varying diets. In addition, there's also the aspect of feeds which is critical. Locally available fish feed ingredients documented and proximate analysis conducted to inform formulations. Locally pelletized and commercial feeds have been tested on their effects on Nile tilapia growth and survival in cages in Lake Victoria with KMFRI pelletized feeds emerging 2nd among local and imported commercial feeds

“We have quite a lot of commercial industries in the country, government lead support, private sector small scale and large scale getting in feed production. The big question would be at the end of the day, are we able to break even as investors. What is it that is not making it possible for feed production in this country? What alternatives can we have so that we are able to cut the costs” said Orina

Potential omega-3 rich aquatic marine and freshwater macrophytes documented and high value species analyzed for essential amino acids. Selected species have been included in fish feed formulations and on-farm growth trials successfully carried out. KMFRI Sagana centre is working closely with ICIPE on replacement of fish meal with insects (Black soldier fly). Mass culturing achieved, processed and feed formulated and tested.

Potential Technologies

KMFRI Kegati has initiated the adoption of above ground wooden backyard pond technology for small scale and peri-urban land owners. Meanwhile, KMFRI Sagana and Sangoro are enabling fish hatchery operators adopted the greenhouse system for enhanced performance. KMFRI Kegati is working with World Fish Centre (Egypt) in the adoption of in-pond raceway by farmers in Kenya. Post harvesting value addition is also very critical. KMFRI Sagana is leading the aquaculture division in fish value addition, products development and shelf life assessment. It is also important to have a marketing information platform - farmers may not know where the consumer is and vice versa. This is critical so that people are able to meet at a virtual market, and they're able to trade without necessarily physically traveling from one point to another. Also, it would be prudent to improve coordination between the national government and the counties, the research firms and the counties and public and private sector is critical for policy initiatives.

Policy Gaps in Aquaculture in Kenya

- Lack of support on budget allocation at County levels;
- Poor national and county synergy on sector promotion;
- No clear cage guidelines yet;
- Low consultative approaches to policies, frameworks and regulations;
- High power tariffs;
- High import duty;
- Restrictive movement of genetic material;
- Unfavorable fish market competition.

E. Potential Capacity Building in LVB Fisheries and Aquaculture

Alison Field-Juma - (CJLF Vice President)

There are 4 overarching ideas for in capacity building. First, it is important to think broadly with a watershed approach. This is because, everyone is both upstream and downstream of someone else; a farmer upstream on River Nzoia can affect someone fishing in Lake Victoria or in the economic system. Aquaculture can stimulate the local ecology economy - as discussed - or compete with others for limited resources. Thus, it is important to think about how our actions affect others. And also by integrating different fields - ecology or biology, economics, sociology, business to avoid the negative impacts and enhance positive possibilities. Having co-benefits cannot be gainsaid, and especially in relation to supply chains about how our renewed focus on supply chains can have multiple positive impacts on land use and on livelihoods.

Thirdly, effectively building and using information technology and related networks is key. It is important to advocate and build the infrastructure that we need to effectively communicate not only to build local and regional knowledge but also to access global knowledge. Finally, we need to share that knowledge to increase the impact through educating, self-education, training etc.

Prof. Juma focused on discovering new ideas and experimenting with them. Thus, we need to expose ourselves to new ideas and pilot those new innovations, which often involves risking failure, but it's worth it. In this respect, CJLF is in its start-up phase and needs to raise money and work with partners like ACTS who are aligned with our values and also within the Lake Victoria Basin and globally. The foundation aims to create a local digital learning hub or resource center for access to global information and use that knowledge. It could be made of bricks and mortar but it could also be virtual and may take different forms as circumstances allow. CJLF aims to support innovation, which can be done through contests convening thought leaders through such seminars aimed at improving the understanding of policy and how it affects change and the values of environmental sustainability, gender equity, and supporting the productive role of youth in local economies. And also strengthen the feedback loop between policy and on the ground work. This means that practice should inform policy and institution building and vice versa. What would CJLF like to see happen in Lake Victoria Basin? Peace, justice and strong institutions all of which rest on a healthy and resilient lake ecology. This will be based on a clear vision which builds from the bottom to the top.

Highlights from the discussions

Dr. Joanes Atela

There are quite substantial innovations geared towards solving specific socio-economic challenges and taking into account inclusion, gender discrimination, lack of information, empowerment, and of course lack of proper upscaling. However, there is little reference to research in terms of how it interacts with these innovations. There is a huge potential by the government or the private sector to act as knowledge brokers. Meanwhile, research is more focused on theories and concepts. In this context, platforms like the CJ seminar series can help bridge that gap and ensure that research is linked is much closer to the solutions that we expect in this society and in line with the Sustainable Development Goals.

VI. Closing Remarks

Angela Christiana, Executive Director, CJLF

The CJLF Chief Executive appreciated presenters and panelists for their very insightful contributions to the seminar and also to ACTS for their commitment to the legacy of Prof. Calestous Juma. The key take-away from this seminar is how we can apply STI for development especially in the context of SDGs. And also to ensure that the most marginalized have access and input into STI development initiatives.

The months following Prof. Juma's demise, his family, friends and colleagues and students sought the best way to realize his vision to address many of the challenges we've heard about here today. Therefore, starting small with an activity with a proven track record would be the best chance for creating an initial success upon which his legacy can be built over time. With that in mind, the focus has narrowed on Prof. Juma's life and work. The first program area will focus on practical and geographically targeted. Through partnerships with local organizations and institutions, CJLF plans to direct and mobilize resources to build local, institutional and individual capacity for integrated sustainable development in the Bunyala region. A need assessment has already been in Port Victoria and a team of local advisors constituted while exploring partnerships with local institutions. The goal is for local stakeholders to identify needs, challenges and opportunities and to mobilize resources.

The second program focuses on elevating Prof. Juma, who was well known for his networking skills and his generosity of sharing knowledge, in global platforms such as the CJ Seminar Series.

“We are using our platform and our brand to highlight, elevate, and endorse the good work that the CJLF, partners and others are doing in the area of STI for development” said Christiana.

The third program of focus area is to partner with other organizations to advance leadership and STI for development, taking a bottom to top approach to enhancing leadership skills by engaging leaders at the Community level. The fourth program focus area is to remain an integral part of the dialogue on STI for development to ensure the legacy of Prof. Juma is preserved and his vision realized through a forthcoming autobiographical memoir as well as memorial events.

DAY TWO

VII. Welcoming Remarks

Prof. Tom Ogada, Executive Director, ACTS

Prof. Ogada welcomed panelists and speakers for the second day of the CJ seminar series. The first item on the agenda was a biographical memoir of Prof. Juma to be read by Prof. Norman Clark. The purpose of the seminar series, organized jointly by ACTS and CJLF, whose purpose is to keep alive the legacy of Prof. Calestous Juma's life. Prof. Clark had a long history with Prof. Juma and supervised the latter during his PhD at Sussex.

VIII. Presentation CJ Memoir

Prof. Norman Clark

Before he passed away, Prof. Juma had been writing an autobiography, which CJLF will publish privately; it will be a fascinating account of his life, not just focusing on academics. Prof. Clark revealed that he knew Prof. Juma as a teacher before the latter became his colleague. It began in 1981 when Prof. Juma applied to a new postgraduate program in Science and Technology Policy Studies at the University of Sussex.

At the end of the Second World War, the UK Government set out to revitalize higher education. Up until then, it was dominated by Oxford, Cambridge, the Scottish universities and the big 19th century civic universities like Manchester and Birmingham. These were traditional structures of departments and faculties and disciplines. The Robin's report, which was published in late 1950s, early 60s, shifted the focus towards fitting graduates to new types of jobs in industry, commerce and banking; and move away from what existed in the early part of the 20th century and during the Second World War. Sussex University is one of these new universities. Thus, Sussex University, instead of having faculties and departments, had schools of study which had subject groups within them. Therefore, if one wanted to study for a degree in economics at Sussex, you would have to do it within a school. The idea was to build bridges across disciplines and get people to talk to each other and produce students who understood and had wider view of more than just one narrow area. The university also introduced the art-science scheme where all undergraduates who were doing a science course had to do one art subject and all art students had to do one science subject thereby building a bridge across the arts and the science.

Meanwhile, new types of self-funded research institutions were also created which were not part of the Sussex University's academic formal structure. Examples of these were the Institute of Development Studies, Center for Insurance Studies, Center for Operations Research, and of course, Science Policy Research Unit, which was established by Christopher Freeman in 1966. When Prof. Clark was appointed to set up a post graduate program in Science and Technology Policy Studies, which was formally accepted by about October 1982, Prof. Juma was among the new postgraduate students and one of these was Prof. Calestous Juma. Prof. Juma was by then well known in Kenya as a journalist and an environmental activist and heavily connected to UNEP and to the Environmental Liaison Center International, a watch-dog of UNEP. However, Prof. Juma did not have a first degree; he had started off as a secondary school teacher in Mombasa and had trained himself to become an environmental journalist under Philip Ochieng, a renowned editor with the Daily Nation. Due to the fact that he had no formal university education, it was difficult for him to get into postgraduate studies because he had no first degree. Nevertheless, he was enrolled in the new Master's program in science, technology and industrialization. His thesis was on photovoltaics: The engineering aspects of development of photovoltaics which he completed within a year. The thesis was so good that his external examiner recommended that he be enrolled for a doctoral degree. He started on his doctoral degree which he completed in record time 2 and a-half years.

In 1986 Prof. Clark and Prof. Juma joined hands to author a book which was published in 1987 focusing on how economic systems evolve through the lens of science, technology and engineering. That's where it all began for Prof. Juma. As was always the case then, doctoral degree holders, often became consultants and worked for international

agencies. However, Prof Juma took a different path focusing on building capacity to understand science, technology and engineering amongst all institutions and all people at all ages in Africa. He used various mechanisms to achieve this and wanted to set up an organization which was connected to development and, of course, based on African issues. He met and married Alison Juma and they both came out to Nairobi and decided actually to set up a new institution oriented towards the environment and development. It was an enormously difficult thing to do and funding was a problem. So Allison and Calestous set up a small publishing company called Initiatives to publish scholarly books. They didn't make much money, but they made enough to keep things going. They got help from small grants and foundations and key individuals like Diane Rocheleau from Ford Foundation and Harold Miller from the National Council of Churches. They were also helped locally by key people like Catherine Wangler in the President's office, Jackton Ojwang' who was a senior legal figure.

When they set up the organization, they had a challenge with recruitment of staff. There was no potential staff with a degree in science and technology policy. So the organization took interns coming out of universities who could then learn on the job and that is how ACTS was set up. And by the time Prof. Juma left in 1995, Prof. John Mugabe took over, it was actually doing pretty well. In fact, up until 1996, ACTS was an NGO, an ordinary Kenyan NGO. John Mugabe turned it into an international governmental body. While at ACTS, Prof. Juma introduced a capacity developing program, which was focused on the outcomes of ACTS policy research. In his experience, many government officials in Africa didn't perform this function well; the civil service simply carried these policies out but there was no sense of policy analysis. There was no feedback coming from the officials to the ministers. Policymakers didn't talk, so there was no policy analysis going on in many African countries and Prof. Juma wanted to change that and set up this program and got primary funding from Norway and other institutions. Over 200 people were trained through this program between say 1994 and 2011, both under Prof. Juma and later under Prof. John Mugabe and Prof. Judy Wakhungu. Many people in senior positions now in many parts of Africa actually have been through that program.

Prof. Juma returned to Kenya in 1987 with a growing belief in the need to promote better environmental sustainability at a global level. In 1987, a report of the World Commission of Environment and Development, chaired by the Norwegian Prime Minister Gro Harlem Brooklyn, was released and which had many of the ideas that Prof. Juma had been toying with ELCA in Nairobi. He authored *The Quest for Harmony*, which was published in 1980 focusing on renewable energy and the engineering of that to promote technology and sustainable development. Meanwhile, he was working on a new book called '*Gene Hunter*' which was eventually published in 1989 focusing on the potential threat of biotechnology to developing countries, whose source was plant based genetic materials engineered by international pharmaceutical or corporations. He also became part of a network organized by the International Federation of Institutes of Advanced Studies. He went on to become the director of the Epeius Biotechnology program and was responsible for editing the journal '*Bio Policy International*' in 1989. At the same time, he helped author a report on the environment and development in Kenya '*Sustaining the Future in Environment and development Kenya*'. Later, he became closely involved with the setting up of the First United Nations Conference on Environment and Development - the Earth Summit - which took place in 1992 in Brazil. Eventually, he became the Executive Secretary of one of the outputs of the summit - convention biological diversity - from 1995 to 1999.

Prof. Juma joined the Kennedy School at Harvard University and later appointed Professor of practice of International Development which made him become an advisory figure at all levels. At the end of his tenure, he began putting all his experiences and knowledge in a series of books and publications. The biographical memoir will help introduce people to his autobiography and from which many will learn much more about his background, supportive parents and how he managed to make it through and eventually became a key international figure. And of course, creating ACTS in the process.

Prof. Tom Ogada

The focus of this seminar is about the link between Science, Technology and Innovation (STI) and Sustainable Development Goals (SDG). Therefore, the question is how do we use STI to realize sustainable development? Given that 2030 is just about eight years away, there is immense pressure to move with speed to achieve SDGs; and that is where the role of STI comes in. How do you then carefully select and deploy STI in a large scale to have enormous

impact on the realization of sustainable development? Yesterday, there were presentations demonstrating STI for SDG's in action through projects supported by UNDP in Busia. Today's session will offer insights on a pilot project spearheaded by the UN - STI for SDG roadmap which began in 2018. There are also other presentations lined up key of which is the STI for the SDG road map by Dr. Boateng, the Director of the Division of Science Policy and capacity building at UNESCO. There will be useful feedback and update on case studies from pilot projects in 5 countries, three of which are from Africa: Kenya Ethiopia and Ghana followed by a panel discussion.

IX. Overview of STI for SDG Roadmap Global Pilot Project Case Studies

Dr. Peggy Oti-Boateng - Director of the Division of Science Policy and Capacity Building in the Natural Sciences Sector, UNESCO

The Technology Facilitation Mechanism (TFM) was launched in 2015 to support implementation of Agenda 2030 and contribute to the achievement of SDGs. A key entity of TFM is the UN Interagency Task Team (UNIATT) on STI for SDGs. Essentially, UNIATT are working groups formed on specific topics relevant to STI with representatives drawn not only from different UN entities but also from other international development agencies. It has different work streams that address different topics; one work stream focuses on the development of STI road maps. Another work stream focuses on development of an online platform on STI for SDGs and also a working group on capacity building as well as gender on STI. The working group that designed the global pilot program on STI for SDGs road map is composed of different UN agencies notably UNCTAD, UNESCO and the World Bank with contribution from OECD and the European Union's Joint Research Center.

The Global Pilot Program

The global pilot program is a policymaking organ whose main objective is align the SDGs with actions in STI. It was designed by the UNIATT group through discussions and meetings in 2017 and 2018 and officially launched in July 2019 during a high level political forum in New York. It started with five pilot countries: Ethiopia, Ghana, India, Kenya and Serbia and later Ukraine also joined the pilot program. In 2021, it was adopted by a UN General Assembly resolution pointing to its strategic importance and greater political coherence in STI. The UN guidebook for the development of STI for SDG roadmaps is the reference document for this program. Developed jointly with the UNIATT and commissioned by the World Bank, this technical document provides a step by step approach for the development of STI road maps. It is meant to be a practical tool for countries that embark in the process of developing their STI road maps. The guidebook was published and translated in eight languages: English, French, Spanish, Russian, Arab, Chinese, Japanese and Portuguese. It also has two background papers which reference work on this program. The first paper provides information on the different methodologies and different tools that exist in the different UN agencies that serve as input and contribution to the work on the STI for SDGs road maps. The other is a paper promoting STI international cooperation.

The UNIATT team launched a series of policy briefs to gather findings of the different activities and work on STI for SDG's road map. There are also regular progress reports on the achievements of the global pilot program. However, the most important part are the countries' achievements, mainly those that have embarked in the whole process of developing their STI for SDGs road maps. Currently, the pilot program is being expanded through a new initiative - Partnership in Action - which resulted from the need to scale up the program. At the moment, many countries have expressed interest to join and develop their STI road maps and numerous discussions have taken place to organize and mobilize multi-stakeholder support for the pilot program with a view to including more countries and how to accelerate translation of the political ambition and preliminary findings of the road maps into policies and practical STI solutions.

The Role of UNESCO

UNESCO currently has three major science recommendations on science and scientific researchers that was adopted in 2017 by UNESCO's General Conference, open science and lastly ethics of artificial intelligence. These recommendations form UNESCO's guiding principles for actions in STI and also provide guidelines for member states in this area. As part of the partnership, UNESCO provides expertise and experience through technical assistance and capacity building to member states on state policy development, reviews of course implementation, monitoring and evaluation and capacity building. This is done through a methodology known as the Global Observatory on Science, Technology and Innovation Policy Instruments (GOSPIN). This methodology has been applied as part of the diagnosis phase for the development of STI for SDG's road maps. In addition, UNESCO has the mandate of sharing information, working with decision makers to build a stronger evidence base through production of international reports.

A. Status of Science, Technology and Innovation Roadmap in Ethiopia

Mr. Desta Abera Shanko - Director, Policy, Strategy and Future, Ministry of Innovation and Technology, Ethiopia

Ethiopia has been struggling to revise the STI policy and, therefore, this presentation focuses on the status of STI in the country - activities, challenges and opportunities. The Ministry of Innovation and Technology is mandated to lead, coordinate and manage technology, research and innovation at the national level. The country has almost 10 regions and two city administrations which coordinate science, technology and innovation activities in their respective regions. Currently, the country's STI policy, which is being revised, will focus on creation of jobs and wealth and how these contribute to GDP at the national economic level. Ethiopia is aware of the importance of the STI sector and how it is related to SDGs. Thus, the main focus of the STI road map are digital economy, science museum, research support, science Café - which focuses on the participation of science and innovation activities. The country has almost 20 STI road maps but which needs to be revised so as to link them with SDGs. In 1980, Ethiopia developed science and technology policies and in 2020, the Ministry of Science and Technology was established; now there is the Ministry of Innovation and Technology, which is focused on agriculture by adopting technology transfer mechanisms mainly focusing on capacity building. There is also a STI policy which focuses on 11 critical issues, 46 strategies and around 27 goals. The main critical issues are technology transfer, science and technology, human resource development, research, finance incentive mechanisms, infrastructure, IP system, national science technology information centers, environment, international relation, and university industry linkages.

Main Achievements

Ethiopia has also established national standard conformity assessment institutions. Other institutions include the Ethiopian Biotechnology Institute, Ethiopian Intellectual Property Office, Ethiopian Science and Technology in Space Science and Technology Institute accreditation. There are also two universities that specifically focuses on science and technology activities in addition to the Ethiopian Science Academy. Agricultural research institutions have also been established over all the 10 regions with more than 55 research centers. Meanwhile, there also exists the National Agriculture Research Council and industry focused institutions based on textile, laser, metal, food, beverage and pharmaceuticals in addition to institutions supporting meat and dairy development. There are also plans to establish two institutions: industrial development capacity building institute and industrial R&D and technology transfer institute. There are also health research institutes mainly working on the health areas to links science, technology and innovation activity to the industrialization. ICT villages have also been established mainly working on the ICT and digitalization; these villages are composed of four units: a business zone, a commercial zone, an assembly and warehouse zone and knowledge creation zone, which focus on digitalization of the country.

There are also industrial parks around the capital city in Addis. And also in Adama which is 100 kilometer from Addis Ababa. These parks are important because they link technology transfer and technology development to industries. With regard to governance, the National Science Technology and Innovation Council, led by the by Prime Minister,

is composed of members from the Ministries of agriculture, industry, finance and health. The Minister of Innovation and Technology is the Secretary of the Council. There is also the National Science and Technology Research Council, which is a sector based research council under the National Science Technology and Research Council with a technical committee that evaluates the main or major cross-sectional research titles and research activities. In addition, there are more than 70 university-industry linkages fora on agriculture, textile, laser, metal engineering, food and beverage, pharmaceuticals and 125 sub-regional industry linkages. Currently, plans are underway to develop STI roadmap framework towards Vision 2025 in Ethiopian calendar and beyond. So far, there are 20 sectoral STI roadmap towards vision 2025. However these roadmaps are not linked to SGDs. Nevertheless, it is important to note that the country's STI activity is closely linked with Agenda 2063 and the PAN African initiatives. The African science and Technology Strategy is also closely tied with the country's STI sector especially with regard to TVET and universities. There are three categories of universities: those focusing on general studies, those focusing on research and those that focus on science and technology universities.

Challenges

The main STI challenges in Ethiopia include: low levels of R&D which stands at 0.25% of GDP. Low human capacity of research, low level of technology development and low level of engagement in research among private sector players.

Questions and Answers

- How do STI institutions and universities interact to tackle innovation dilemmas in Ethiopia? How do the national university- industry fora operate? What are the key components of the technology roadmaps?
- There are some African countries that might be interested in joining the UNIATT global pilot programs; what are the requirements?

Desta Shanko

Coordination of STI activities in Ethiopia is vested on Ministry of Innovation and Technology. The National Science and Technology Council, led by the Prime Minister with the, focuses on strategy issues and oversees all ministries at the central level. Given that STI is cross-cutting, the Council coordinates all issues related to the sector including budgets, the technology transfer and digitalization. The Minister of Innovation and Technology is the Secretary of the Council. There is also a department which is working on the coordination of science and technology at the regional level.

B. Status of Science, Technology and Innovation Roadmap in Ghana

Dr. Wilhemina Quaye, Director CSIR, Science, Technology Policy Research Institute, GHANA

This presentation focuses on mainstreaming STI for SDG's in Ghana, one of the African countries on the UNIATT global pilot program alongside Ethiopia, India, Kenya, Serbia and also Ukraine. Ghana has paid special attention on integrating STI into a national development plans to be able to achieve the SDGs. It is important to note that the country is keen to integrate or mainstream STI into development planning and have been supported in these efforts by UNESCO as well as the Ministry of Environment, Science, Technology and Innovation. It took Ghana about a year and to get the strategy or the STI for SDG road map concluded. It started off by getting to know who will be involved in the technical task team. In 2022, a situation analysis was conducted which formed the basis of publishing policy briefs and other knowledge products. By February 2021, the STI for SDG strategy was ready. Then began the process of dissemination and sensitization and mobilization of partners.as well as resources for implementation.

The process was ably supported support by UNESCO and the Swedish International Development Agency (SIDA). In developing the roadmap, several documents were reviewed mainly the national development plans and the STI policy, which is currently due for review. It was deemed important to have the STI for SDG roadmap integrated to

the development plans and development agenda as well as the state coordinated program of Economic and social development policies. Thus, the STI for SDG road map has to prioritize SDGs 2,3,4,9 mainly because of the industry and innovation; and also SDG 6 on sanitation and water because Ghana is deficient in that area. Thus Ghana's STI for SDGs has prioritized agriculture, health, industry and infrastructure. There is also a focus on the innovation hubs to showcase the work of the youth in all these activities towards the SDGs. The roadmap include activities for each of the sectors, expected outputs, responsible ministries/ agencies, and the budget for each. As part of the situation analysis, a SWOT analysis on the status of STI was also done to determine the strengths, weaknesses and opportunities? In Ghana the key issue around the STI ecosystem is job creation and the situation analysis showed where the country needed to be in 2030. Percentages were also pegged on specific sectors. For example, the agricultural sector requires 100% self-sufficiency; and for this to happen, it was important to strengthen research for improved processing and value addition and improve international trade. In education, the focus is on inclusivity on open size infrastructure and quality competence and employable skills.

One of the key objectives of STI roadmap for SDGs in Ghana is to bridge the gap between research, academia and industry. Due to the COVID-19 pandemic, there was need to strengthen application of STI in the health system, especially in emergency response in public health, water and sanitation. It was important to develop activities in STI that could help us to improve on water quality. In industrial transformation, an assessment of application of frontier technology as at 2020 revealed that most industries were not using frontier technologies needed to achieve STI goals for SDGs. There was also an examination of STI capabilities in terms of human resource, governance structures, infrastructure and related processes, output as well as knowledge exchanges focusing on agricultural, industry, health, education and sanitation. Developmental challenges were also examined, the role of the public and private sector, and what interventions and enabling environment could be put in place to fast track the achievement of SDGs. the role of the youth is also paramount in the roadmap. Ghana does not have much in terms of generation 4.0 technologies and much needs to be done in this area. In conclusion, Ghana's STI road map has a vision with specific interventions and related budget, coordination mechanisms as well as monitoring evaluation parameters. Another key element of the strategy is partnership and communication. The country is now mobilizing resources and also partnership strategies and adopting new emerging technologies, which require both in terms of financial and human resources to fast track the application of STI for the achievement of SDGs.

Mr. Naoto Kanehira - Senior Strategy and Operations Officer, World Bank

Updates from the pilot countries means they are all on the same boat although facing different challenges. Through this experimentation on STI for SDGs countries learn by doing and from each other. It also helps accumulate experiences not only at the country level but also at international level and as a result, they learn to work together. Different development, organization than the UN agencies have different positions and while countries have different levels of capacity, sources of funding and different level of awareness. In addition, citizens, researchers and the industries also have different advantages as well as limitations and constraints; it's all about bridging all these differences and sharing and advancing higher level objectives and accelerating the progress. The COVID-19 pandemic pushed us back although there are many years left before 2030. Thus, the achievement or progress being made in private and countries are really encouraging; but we are not there yet. Therefore, regional and continental institutions such as ACTS and African Union are expected to play a catalytic role by making connections, upholding shared aspirations and bringing people and institutions together.

C. Status of Science, Technology and Innovation Roadmap in Kenya

Dr. David Njubi

This presentation is an overview of STI for SDG in Kenya, one of the pilot program countries for STI on SDGs. The technical draft on STI for SDGs was developed by a technical team supported by ACTS. NACOSTI is deputizing the National Treasury which is heading the STI for SDG. The team developed a draft document which was shared by stakeholders who identified agriculture and manufacturing as key areas with ICT as cross cutting theme. Kenya has been implementing the Big Four agenda by the government focusing on health, housing and manufacturing and food

security. The draft STI for SDG draft document focuses on agriculture and manufacturing with ICT as cross-cutting. Various technologies and as we have been engaging with World Bank and other institutions. There has been some progress particularly in agriculture not only with regard to digital technologies and providing or facilitating inputs but also in terms of facilitating farmers to get markets for their products. NACOSTI is mandated to come up with research priorities to be pursued by different ministries, departments and agencies. The NACOSTI structure incorporates ministries at the steering level and CEOs of different agencies who are implementing the STI. In the last financial year, the government allowed NACOSTI to mainstream STI in the ministries, departments and also agencies. That implies that NACOSTI will be able to know what is happening in different ministries in terms of STI and also agencies. The agency has been collecting this data and will be analyzed to know the progress for example SDG 1, 2, 9 and 8. Thus, Kenya making progress on STI and SDG in various SDGs.

X. Panel Discussion on STI for SDG Roadmap

Prof. Tom Ogada, Executive Director, ACTS

ACTS has been involved in the process of the STI roadmap for the SDG since 2019. The organization participated in the third meeting of the expert group in Belgium in 2018; and together with the World Bank and UNESCO, organized the fourth expert group meeting in Nairobi, where it provided the technical support to the Kenyan pilot project. Later, ACTS mobilized STI agencies to develop a proposal to upscale the STI road map for the SDGs. The first key lesson arising from this process was that there is weak interagency collaboration between agencies responsible for STI and SDGs. Much progress has been realized, particularly in Kenya, by the National Treasury and the Department of Planning - the custodian of the SDGs in the country. However, this was achieved without collaboration with agencies responsible for STI's and vice versa. It is only through the STI roadmap where, for the first time, the agencies responsible for SDGs within the country were able to work together with those responsible for STI.

Secondly, there is inadequate knowledge of country specific SDG gaps by the STI policymakers. Those from the STI policy arm, always believe their policies are linked to STISA 2024 and SDGs but are unable to expound on which specific SDG goals and gaps are being addressed with the STI. Therefore, the STI for SDG roadmap is an opportunity to link STI strategies, STI policy plan to address specific SDG's and specific gaps within the SDGS. Thirdly, the STI road map becomes a useful tool for implementing policies and ensuring that STI is used to address the SDG gaps. Most African countries are currently striving to revise their STI policies because they are outdated. Some countries also have ST without the 'I', because they were developed before focus was given to innovation. In addition, there are always good policies in Africa but implementation is always a challenge. Therefore, the STI road map is a useful tool to develop plans for implementation of our STI policies.

The fourth lesson learned is the role of the stakeholders. The STI for SDG process is stakeholder driven and mapping them and ensuring they actively engaged is critical to ensure STIs are prioritized by finding out which stakeholders can address which STI within specific SDGS. Finally, the process of STI for SDGs must be linked to existing government policy strategies and plans. The presence of clear vision and development plans Like in the case of Kenya, which is guided by Vision 2030 and the Big four agenda focusing on four sectors, agriculture, manufacturing, health and housing. However, the main challenge remains data, which is required to identify the gaps particularly with the SDGs but also to help understand STI related challenges that makes it possible to address specific SDGs. UNESCO and other partners are working on this to create evidence that can be relevant and applicable to African situations and which policymakers can relate to and associate with.

Finally, developing an STI for SDG roadmap is good but implementing is the most important aspect of it. Given that implementation require resources makes it crucial from the beginning and must be owned and driven by the government. When the roadmap has been developed the government can support mobilization of resources to implement the projects identified in the road map.

Prof. Juma prepared a report for the African Academy of Sciences titled *Africa beyond 2030* putting forth strong views on STI for SDG's in which he argued that some African countries will not implement STISA and the Agenda 2063 if they develop roadmaps because the countries already had enough strategies. He also argued for the abolition of all the ministries and departments responsible for STI and get African presidents to be responsible for STI. That that report, 'Africa beyond 2030', was published in 2018 by the African Academy of Sciences. For those who focus on STI for SDGs, it would be prudent for African countries and other developing regions to use SDGs to shape their future investments in STIs or shape its direction as opposed to worrying whether STIs are going to help achieve the goals in the next 7 or so years. Though this view is controversial, it is important to think whether it is STI for SDGs or SDGs for STIs.

A. Questions and Answers

- What are the instruments that have been put in place to make the roadmap become operational; are there examples of examples of relevant instruments to operationalize the roadmap?
- How is the STI policy in Kenya and how has it been integrated into economic policy planning and programs?
- How would you rate the level of implementation of STI policy in Kenya and what are the key lessons that can be highlight?
- Other countries can highlight some of the key lessons emanating from integration of STIs into development planning and the implementation level of STI policy.

In Ghana, the development agenda puts a lot of emphasis on innovation by preparing to apply the STI. However, the country is still in the process of mainstreaming STI into development plans and once that is done implementation will be easier. Ghana is being supported by UNESCO and SIDA to strengthen the STI system and offload some of the activities in the road map.

In Kenya, there has been some disharmony among the various players and efforts are underway to have the different players work together and things are improving. In terms of digitization, Kenya is doing well and digitalization technologies being funded by Japan and the World Bank. Most farmers in Kenya are using mobile phones and they can be able to know what seeds and fertilizers can be used on their farms.

Mr. Naoto Kanehira – Senior Strategy and Operations Officer, World Bank

Many questions around operationalization, implementation and the knowledge gap on the explicit link between STI policy and achievement as well as lack of data are valid. The challenge is that it is relatively easy to create something in the form of national coordination bodies and produce a document like a national road map. However, it's relatively difficult, and it's intrinsically challenging to demonstrate the progress being made and exercising accountability to guide and changes to continuously make and accelerate the progress. There are three key ministries that are crucial to support the connection between STI and SDG. The first is the Ministry of Finance for budget purposes; then the Ministry of Industry and Economic Development who are needed to rope in the private sector' and thirdly the Ministry of Higher Education, because you need to engage universities and research institutes. All these three ministries have typical behavioral patterns.

When promoting STI policy, one must be aware of what is happening behind the scenes. The most important aspect of implementation of the STI policy is political will. Therefore, it is not wise to take things at face value. If there is conviction political will, there should be the budget and it is the work of relevant ministries to reallocate, mobilize to create the physical space to achieve the necessary objectives. When engaging with the Ministry of Economy and Industry, it is their responsibility to encourage private sector and mobilize private effort and make connections but they are always very cautious. For example, the typical response for the Ministry of Higher Education and Research

is always that ‘we are already doing it’. The UNESCO pilot program is important because it is creating this community of practitioners who continue to learn from each other without being complacent and overly optimistic. However, maintaining our professional curiosity and professional commitment to really achieve something through STI and it would be very important and provide a lasting legacy to Prof. Juma.

XI. Steering Agri-Food System Transformation: Role of STI

Moderator, Dr. Joshua Owade, Head of the Agriculture, Food and Nutrition Security

This session is geared towards SDG 2, with a team of experts engaging in discussion and ideas deriving from their projects and experiences in different countries. In the first segment, Dr. Linus Kosambo from the Research and Development Institute distills insights on the integrated multi-trophic aquaculture based on a project being implemented in the coastal region of Kenya.

A. Innovation in marine fisheries and its potential for economic empowerment

Dr. Linus Kosambo, Integrated Multi-Trophic Aquaculture (IMTA)

Integrated multi-trophic aquaculture (IMTA) is a new approach to aquaculture which has been applied in other areas of the world. This presentation provides the economic potential of IMTA with regard to fish production in Kenya, which is still a net fish importer. The situation will get worse with the rising population and the dwindling stocks, which is an indication of the consumption of fish. Kenya per capita fish production is around 4.5 while globally it is 20. IMTA consist of using, rivers, lakes, dams, swamps and ocean to produce different species. For economic sustainability and also for environmental sustainability, seaweeds are sinks of carbon and therefore climate smart. So the IMT system can also include high value species such as lobster that can fetch up to KES 2500. At the same time, it involves mangroves in the agriculture system - Silvo aquaculture - for environmental protection. The institute works closely with communities in Kilifi, Kibokoni, Kijiweni and Sunza in Mombasa County where farmers are being trained on how to have many species on the same production systems. The project has developed economic and business plans and indications of the economic benefits are positive; the cash balance is good so it can be sustainable in the long run.

Opportunities and future prospects

There are vast research opportunities in IMTA in various areas including site selection, infrastructure development, diversification and domestication of farm species; affordable sustainable feeds also need to be developed. The project intends to integrate this with other technologies including solar technology for cooling and drying. Some of the products with economic benefits include seaweeds which are antifungal, antimicrobial, antiviral, and anti-cancer. Thus extraction and value addition to seaweeds can gain much economic value for communities. Seaweeds are important in paper industry, filtration, bioethanol and biotechnologies. Currently, the institute is adding value through production of soap and some other cosmetic products from seaweed to increase returns to farmers. Seaweed can help in biomass and power production. In addition, design of cages and construction of cages has huge potential. KIRDI is a leader in leather production and the project is producing leather from all kinds of animals, including fish. And as production level rises, more leather will be able gotten from fish. The project is also seeking partners for Aqua Labs to be set up system in the ocean for further studies on the best way to harness marine resources.

The institute has several projects, one of which is called Sea-fort that is handling and seaweeds amaranthus and finger millets. There is also co-marifish project for commercialization of different products; blue empowerment project that is dealing with the empowering women to handle matters of blue Economy. The main partners include ACTS, Kenyatta University, Technical University of Mombasa and Bahari CBOs. Currently, the institute is testing systems and are hopeful that as more scientists and partners will join their innovation platform and to open new economic

opportunities to benefit the local population. The institute is also working with ACTS to digest to synthesize the different policy opportunities and policy pathways that can help us to integrate IMTA in Kenya's economic system.

B. Community Cooling Hub – Tapping into clean-energy solutions for reducing agricultural post-harvest loss in Africa

Dr. Catherine Kilelu, Head of the Agriculture, Food and Nutrition Security

This presentation focuses on opportunities for tapping into clean energy solutions for agri-food systems transformation in Sub-Saharan Africa. They're various STI activities zooming in specifically on some of the interesting work being undertaken by ACTS to demonstrate what STI can contribute or catalyze in agri-foods, especially sustainable agri-food systems transformation. In this context, some of the challenges facing the continent include high post-harvest losses in the agri-food sector in the region where reports indicate that we lose up to 50% of our food production through post-harvest losses and in some cases up to even 80% in localized contexts. In a situation where 248,000,000 Africans are undernourished – SDG 1 and 2- it is very urgent that we address this issue. Additionally, the agri-food sector itself contributes to greenhouse gas emissions, but it's equally vulnerable to climate change - warm temperatures, less precipitation, or too much precipitation - SDG number 13. In addition, the agri-food sector takes up about 25% of the world's energy usage, most which is not clean - or what we consider renewable energy - SDG 7. There are also interesting developments happening at the technology frontier to support sustainable development ambitions or goals. But there are risks that have been highlighted that show technology advances have the risk of perpetuating inequality, necessitating the need to pay more attention to inclusive approaches in achieving SDG goals 9 and 10.

There is also limited application of nexus approaches to solving problems among actors in the agri-food with limited attention to energy or water challenges. What can STI do to support kind of an enhanced access to clean energy and enable food system transformation in the continent? Increasingly, through global research and development, the cost of renewable energies, such as solar, has reduced enabling access to affordable and reliable energy sources. Therefore, it is imperative that find ways of using STI to tap into clean energy which is more efficient and thus reduce focusing more post-harvest losses as one of the grand challenges; and to develop a more low emission sustainable agri-food system. There are lots of potential in tapping into off-grid solutions related to renewable energy, especially solar, for drying and cooling innovation that is allowing also inclusion of smallholder farmers. Through solar drying in Kenya, there are interesting innovations around solar powered milk chilling systems. Thus, when we talk about clean energy solutions, we must focus on the challenges of dry chain issues. Therefore, drying and cold chain storage, are some of the solution to reduce post-harvest losses.

What is ACTS doing with regard to tapping into STI and bring some of these solutions to action? One of the initiatives are solar dryers where the organization is scaling up an initiative started in 2019 to work on deploying solar dryers to smallholder communities and enable more drying of products that otherwise would be lost through poor post-harvest management. Through this solar drying technology, there are opportunities for climate action enterprises and ACTS is working with the partners including UNEP, especially in the first phase of this initiative. ACTS is also working with Eba Group Pamoja on designing these dryers and also supporting local fabrication by re-skilling youth and building their capacities to fabricate the dryers. Part of the STI research and innovation embedded in initiative is by optimizing the drying time for these dryers to achieve a good quality of dry product of up to 10% moisture content for cassava and thereby address the challenges of mold and mycotoxins.

Institutional innovation around the access and use of solar dryers is also another important dimension. Instead of promoting solar dryers to smallholder producers so that they can buy them individually, ACTS is working through a model where groups of farmers or women or youth can acquire the solar dryers and then offer drying on a pay as you dry. The business model that accompanies the technology also needs to be optimized to enable smallholders use this technology. On this front, ACTS is working on the next phase of scaling up and will not only be deploying more dryers, but also working on optimizing their design and their efficiency in the drying process. Therefore, STI is very

central to this whole model of drying as a service to smallholder farmers which also will enable them not only to reduce their post-harvest loss, but also to tap into the dry food markets that through agro processing.

Another ACTS' initiative is a partnership with the University of Birmingham, London South Bank University, involving local community farming groups to explore the use of clean cooling, technology driven solutions for eliminating or reducing post-harvest losses for produce through cooling. Although the aspect of cooling is not necessarily new, what is interesting is the model that this project is trying to understand the demand for cooling in a much more integrated way. Smallholder farmers do not produce one single product but work with multiple products; so, how do we develop a solution that is much more integrated as opposed to a single value chain approach to finding cooling solutions? The initiative is estimating demand from an economic perspective, and the design aspect where engineering is involved and looking at how to integrate other challenges or other issues that communities are facing, particularly the question of how or whether it's possible to integrate cooling demand for animal and human vaccines, and especially with the COVID-19.

Therefore, the community cooling hub is a living lab where we want to learn how we can use STI driven integrated design concepts for cooling solutions, cooling technology and also how, through this experiment, learn how it will translate in terms of reduction in post-harvest losses, improve diets, enhance access to vaccines, create rural jobs, reduce greenhouse gases emissions and lead to more resilient communities. The novelty in this solution is its integrated nature. The systems approaches to agri food sector development is critical; and the nexus approach on food, energy and the water linkages is critical, as opposed to looking at solutions in isolation. Research-industry partnerships are absolutely necessary but still weak. Interdisciplinary working relationships are also key. In this respect, ACTS is collaborating with engineers, economists, agri business specialists, food scientists, anthropologists, gender experts, innovation scientists and ICT scientists to design these solutions. .

ACTS is plugging into an emerging network of scientists and industry players who are part of the Africa Center of Excellence for Sustainable Cooling that's hosted in Rwanda. These networks are also important in driving the STI agenda in terms of planning and cross learning between countries, the region and across the globe. In conclusion, harnessing the potential of STI and aligning them with the Sustainable Development Goals is important in terms of addressing some of the grand challenges that we're facing as a continent.

C. Evidence for Policy-Making

Dr. Rose Omari, Science and Technology Policy Research Institute

Researchers have to realize the need for evidence based policy making because there is a lot pressure to prove research is having an impact on policy. It is clear that policy development and implementation over the years have been weekly informed by research. There are a number of factors associated with this, one of which is lack of consensus among researchers and policymakers. There is also poor understanding of the policy process by researchers who often make unrealistic recommendations in addition to inadequate capacity of policymakers to make use of the research evidence. A number of organizations have been trying to understand the best approach to actually bridge the research policy gap. The work of Science and Technology Policy Research Institute is to show that researchers can really make an impact. With regard to food safety in Ghana, there are several challenges which mainly include physical contamination, - stones in rice and beans – microbial contamination, and chemical contamination. Some are intentionally added while some like the mycotoxins are naturally occurring.

In Africa, there are about 31 different food hazards contributing to about 91 million food-borne illnesses and about one 40,000 deaths. The burden of food borne disease in Africa is similar to that of HIV/ AIDS, TB and malaria. Aflatoxin is one of those safety hazards with negative impact on health, trade potentials and also on food and nutrition security. In Ghana, there are several projects being implemented which contribute to managing aflatoxin without much impact because, the projects are fragmented and not well coordinated. Thus, scientists and researchers felt that having a policy in place will enable them harness all the collective strengths in the various institutions and among the various stakeholders to effectively manage aflatoxins. This led to the formation of the policy development project.

There are a number of models for bridging research-policy gaps but Ghana adopted the engagement model which ensures a continuous interaction among policymakers, researchers, and all other stakeholders. The main characteristic is that of collaboration and consensus among all the objectives and the goals set. This resulted in the aflatoxin policy development process which started with the establishment of a national steering committee with several functions, one of which was to serve as a champion through advocacy. A situational analysis on aflatoxin was done - the health and economic effects, how to control it, teaching and research capacities, the policy and regulations relevant to aflatoxins and barriers that affect policy implementations. This led to a stakeholder workshop where the findings of the situational analysis report was validated, setting the agenda for policy development.

After a series of stakeholder consultations and several workshops with different groups of stakeholders, a drug policy was developed which will be presented to four ministries: there is no single ministry that can solve the aflatoxin problem. The 4 ministries include the Ministry of Environment, Science and Technology, mainly for research aspects, STI and others; the Ministry of Health, the Ministry of Food and Agriculture, and the Ministry of Trade and Industry. The four ministries bought into the issues and agreed to endorse the policy. A draft policy was developed and is set to that we now presented to the Cabinet for approval. There was a very clear vision which was mainly to improve harmonization and coordination of activities among all stakeholders to effectively manage aflatoxin. The goal was to protect human and animal health and increase income of all value chain access by reducing aflatoxin contamination. The main objective of the policy was to strengthen research and technology development and transfer, because although a number of strategies exist they are only with researchers and not users who manage aflatoxin. Thus, in order to facilitate the approval and implementation of the policy, findings from the four situational analysis were distilled to eliminate barriers that would prevent or hamper implementation of the policy. An implementation plan - with budgets, roles and responsibilities - was developed with provisions for capacity development of all stakeholders. A resource mobilization plan and communication strategies were developed to create awareness about the policy. A grant enabled implementation of and prioritize actions in the aflatoxin policy for maximum impact. Finally, technical regulation were drafted to facilitate the enforcement and compliance with aflatoxin standards.

Achievements

Technical regulations were enacted by Parliament in December 2020. All the four ministers jointly submitted a cabinet memo to Parliament in early November, 2021 and the policy was presented to the Cabinet Committee who recommended that the policy be approved as soon as possible because it was long overdue. There's heightened stakeholder self-awareness and interest in aflatoxin. There are also several knowledge products including situation analysis report, policy brief, and a code of practice for aflatoxin control.

In conclusion, it is important to integrate research evidence in new policy development to improve their adoption and implementation. And development of policy can be initiated by any actor, it doesn't have to come from the policy makers. High level consultation and advocacy are very critical to get governments' buy in which is critical because they are going to implement the policy. Seeking funding through various means, proposal writing and all that and donor engagement is very key while dissemination of output is important to create awareness about the policy development processes and implementation. The media was part of the process right from the beginning as the policy was in the interests of public. Finally, policy development is not easy; it is complex and requires research, adequate resources, time and patience of all stakeholders.

D. Sustainability of Food Systems

Dr. Julius Ecuru, BioInnovate

Bio-Innovate Africa organized three important global events in 2021 which have implications on the food systems. The first was the 6th assessment report of the Intergovernmental Panel on Climate Change (IPCC) report which warned of a catastrophic global warming if carbon emissions are not cut to net 0 by 2050. The second was the food System Summit, which called for an integrated development of food systems. The third, and most recent, was the cop 26 climate summit, where several countries made binding pledges to cut carbon emissions in the foreseeable future. The current food system, in terms of production and consumption, is very unsustainable. In developing countries, farming practices are based on expansion of acreage instead of intensifying production. It is also

characterized by improper use of agrochemicals. On the consumption side, post-harvest losses are extremely high, 40/50% in different countries. Food wastage is also huge and food distribution is weak because of inefficient supply chains. So you have a situation where you have plenty of food in one part of the country and scarcity in another part.

The food systems are very unsustainable and contribute up to 25% of the global carbon emissions. In Eastern Africa, food production and utilization of agricultural residues and bio-waste is suboptimal, because of inadequate application of science and technology with limited innovation to promote value addition and bio or agro processing. Thus, to transform the food systems, first and foremost, it is important to make it more sustainable. BioInnovate Africa is using scientific knowledge to develop appropriate inputs for our farming systems: better crop varieties, using ecological based approaches like bio fertilizers, bio pesticides as part of the intensification process. Innovation helps develop value added products and bringing them to the market as the more sustainable pathway to growth and wealth creation.

BioInnovate is also looking at community bio refineries to absorb farm produce from our farmers and also link farmers to new value chains both locally, nationally, regionally and hopefully globally. Bio Innovate, intends to infuse new ideas in food systems and link to market. The current focus is to value added insect proteins to food and feed value chains and get novel products out of orphan crops like milk and sorghum, which many communities depend on; and also improving seed systems, especially using micro propagation techniques so as not to encroach on lands that can be used for conservation but also using microorganisms, especially industrial processing enzymes.

BioInnovate is also putting emphasis on integrated wastewater management systems to ensure clean drinking water and also water for production. These are important in finding ways to conserve biodiversity, including agro ecologies because it ensures proper regeneration of bio mass, which is a crucial input of its stock to value addition and agro processing activities. There is also the part of integrating digital solutions as part of the innovation process, especially in improving disease diagnostics and pest surveillance. In summary, food systems transformation is critical and needs to be made sustainable by applying science and technology. And BioInnovate is fostering innovations that actually move these ideas, inventions and creating businesses out of them.

E. Questions and Answers

- What are the specific roles that stakeholders play in these efforts? And how are these initiatives that you are doing in the area of the IMTA funded?
- Dr. Omari, can you highlight the key challenges you encountered in their whole process of shaping food safety policy in your country?

Dr. Linus Kosambo

IMTA is collaborating with local universities and international universities to develop training modules and also in designing and disseminating training documents and instruments to the grassroots. They also work together in identifying students and young scientists from universities for internship/industrial attachment not only at the institute but also at business incubation level for field data collection and also for technology transfer. In terms of funding, the institute gets funds from the government but also tap into the National Research Fund by NACOSTI. The institute also collaborates with international partners to get international funding from other development agencies.

Dr. Rose Omari

Implementation of programs at the Science and Technology Policy Research Institute is easy because they have funding. And also because there is evidence to prove that aflatoxin is a problem and which brought everybody on board. The COVID-19 pandemic proved a big challenge because the policy institute was working under tight timelines and some activities, especially stakeholder engagement, could not be conducted due to COVID-19 related restrictions. This delayed the implementation process. Later, there were elections which brought in a new government and the Cabinet was dissolved, which stalled the process for some time. However, things stabilized and the process continued.

Dr. Joshua Owade

Initiatives promoting a non-conventional food sources like in the IMTA means that stakeholders in the food sectors need to think outside the box. Dr. Kilelu pointed out the essence for multi-disciplinary all-inclusive approaches as opposed to working in isolation. And as elaborated by Dr. Omari, it is important to lay more emphasis to evidence based policy development. More importantly, these solutions and the innovations out must be taken up and commercialized.

Dr. Samuel Partey

Many presentations, have focused application of STI in fisheries, aquaculture, food systems, food safety, clean energy and STI for the SDGs. In this context, there's clear evidence for the establishment of STI baselines informed by data. Most presentations have mentioned situational analysis and STI applications in the various sectors linked to the SDGs. However, we cannot have all these without data. There is need to create the necessary evidence, avenues and entry points for developing STI policies. That's part of trying to diagnose the problem and see STI contributions in driving SDGs and national priorities by having STI baselines established based on nationally adopted indicators. For example, Kenya has defined some internationally comparable indicators for STI but there should be targets to determine what is to be achieved by STIs because it is very difficult to develop metrics and contribution of STI to SDGs or national development. For instance, it is difficult to quantify STI contribution to energy security or food security and other social economic sectors.

ACTS have been instrumental in looking at the metrics for STI through desk studies and stakeholder engagement. Once there is good situational analysis of the STI landscape and other innovation ecosystems, it is possible to prioritize STI interventions and policy actions. For example, if the World Bank or any development partner wants to invest in STI, what would be your priorities? Most countries do not have prioritization frameworks for STI. Therefore, as countries conduct situation analysis, it is important to think of priorities through a multi stakeholder approach, which will help develop national STI investment plans. Once we have prioritization frameworks are in place and policy actions have been defined, STI implementing actions plans are designed. There is also need to have monitoring and evaluation frameworks for STI based on established indicators. During the UNESCO General Conference, they approved the recommendations on open science which calls for data sharing, knowledge sharing without any restrictions. This is because if we want to work together, there is a need to share information on what technologies and innovations are supporting specific areas in different countries. This will promote intercountry learning and cooperation and also disseminate good practices.

United nation's Technology Bank is documenting best practices related to SDG targets. So there will be the need to have a compendium of, for instance, homegrown technologies and innovations that are helping countries to accelerate progress towards national development priorities and the SDGs. Finally, there is need for a multi-stakeholder national policy dialogue platform on STI so that different players in the STI landscape work together. For example, in fisheries, there are various actors including research organizations that have developed technologies that can be brought to scale. There are policy think tanks and development partners who are looking for the opportunities to invest in technologies that can drive development priorities. Therefore, there is need for all these stakeholders through a national policy dialogue platform on STI to generate knowledge products such as policy briefs, research papers to improve the science policy interface. There can also be joint review of knowledge products, development of policy tools, methodologies, building capacities of institutions through workshops which have the potential of enhancing the science policy interactions on STI.

XII. Closing Remarks

Prof. Mugabe

ACTS has done a great job of organizing the CJ seminar series seminar; CJLF has a number of plans to follow up on some of the issues that have been addressed. Some of the proposals include building capacity or capacities or various institutions and stakeholders to engage in development policy mainly in aquaculture and fisheries; and partner with a number of international and local institutions to develop concrete activities in Western Kenya and the African continent to advance Prof. Juma's legacy and his work. The 16th of December 2021, would be mark the fourth anniversary of his passing on and the number of activities have been lined up. There have been very rich presentations, discussions and the spirit is that of moving into action, get to the ground and get the work done.

Dr. Catherine Kilelu, ACTS

This seminar has been a source of rich conversations and sharing and in the spirit of keeping the memory of Prof. Juma alive. More than 140 participants joined this seminar, which shows that this is an important conversation we're having, but also that people are very keen to keep the memory of Calestous Juma' alive. The presenters who have given us their time to prepare and to show up and make the presentations. Without them, these sessions would have not been as successful as they have been. Gratitude goes to all the participants and for their questions and active engagement. Special thanks to all ACTS' partners who have closely worked with us to organize this seminar series; CJLF for continued collaboration in this partnership and for all the people that have been working behind the scenes, staff at ACTS who have been working on the IT aspect on getting the message out in preparing the program,. There will be another CJ Seminar in March 2022 where all participants are invited.

XIII. Annexes

A. Seminar Programme



BUSINESS
SCHOOL

SCIENCE POLICY
RESEARCH UNIT

2nd Calestous Juma Seminar Series on Steering Science, Technology and Innovation to Achieve Sustainable Development Goals (SDGs)

29th – 30th November 2021 Virtual Events

Time	Agenda	Facilitator
Session 1		
14:00-14:20	Video clips (CJ and Lake Victoria Fisheries.)	ACTS ICT staff
14:20-14:30	Welcome Remarks Prof. Tom Ogada, Executive Director of ACTS Ms Angela Christiana, Executive Director of CJLF	Tom Ogada
14:30-15:00	Introduction to the STRING Project (UNDP) Report Dr Tommaso Ciarli, SPRU, University of Sussex and STRINGS Project Coordinator/PI	Norman Clark
15:00-15:20	O&A/Discussions	Norman Clark
15:20-15:50	STI Pathways to sustainable fisheries and aquaculture in LVB Prof John Ouma-Mugabe, GSTM, University of Pretoria (STRINGS SSA co-PI) Mr Paul Kombo, County Government of Busia (STRINGS SSA Researcher) Nora Ndege, Research Fellow ACTS (Research support to STRINGS MCM on innovation pathways in aquaculture and fisheries in LVB)	Norman Clark
15:50-16:00	Q&A/Discussions	Norman Clark
16:00 - 16:10	Health Break (10 mins)	

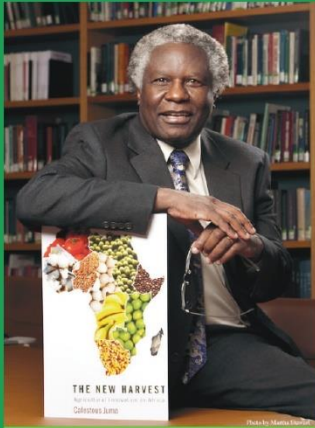
Session 2		
16:10-16:50	<p>Panel on steering STI for sustainable fish production in LVB</p> <p>Mr Dave Okechi (Fish farmer, Kisumu County) Digitizing LVB fisheries for socio-economic inclusion</p> <p>Mr Fred Juma, (Fisher farmer, Busia County) Entrepreneurism in fisheries and aquaculture</p> <p>Prof. Les Kaufman, (Researcher, Boston University) International research and capacity building priorities</p> <p>Dr. Paul Orina (KFMRI) Innovation policies for sustainable aquaculture</p> <p>Alison Field-Juma - (CJLF Vice President) Potential capacity building in LVB fisheries and aquaculture</p>	Tom Ogada
16:50-17:10	Facilitated discussions/dialogue	Tom Ogada
Session 3		
17:10-17:40	<p>Potential follow-up research and capacity-building in LVB</p> <p>Prof John Ouma-Mugabe (GSTM, University of Pretoria) Closing remarks</p> <p>Angela Christiana (CJLF)</p> <p>Dr. Ann Kingiri (ACTS)</p>	Tom Ogada

Tuesday 30th November 2019

Time	Agenda	Facilitator
Session 1		
14:00-14:20	Presentation CJ memoir-By Prof. Norman Clark	Tom Ogada
14:20-14:40	<p>Overview of STI for SDG roadmap global pilot project</p> <p>Dr. Peggy Oti-Boateng - Director of the Division of Science Policy and Capacity Building in the Natural Sciences Sector, UNESCO</p>	Tom Ogada
14:40-15:25	<p>STI for SDG global pilot Project-Case Studies</p> <p>Prof Walter Oyawa – Director General, National Commission for Science, technology and Innovation, KENYA</p> <p>Mr Desta Abera Shanko – Director, Policy, Strategy and Future, Ministry of Innovation and Technology, ETHIOPIA</p> <p>Dr Wilhemina Quaye – Director CSIR, Science, Technology Policy Research Institute, GHANA</p>	Tom Ogada

15:25-15:55	Panel discussion on STI for SDG Roadmap - Mr. Naoto Kanehira – Senior Strategy and Operations Officer, World Bank Mr. Hambani Masheleni – Head of STI Division, African Union Prof Tom P M Ogada – Executive Director, African Centre for Technology Studies	Tom Ogada
15:55 - 16:10	Health break (15 min)	
Session 2		
16:10-16:50	Steering Agri-Food System Transformation: Role of STI Dr. Linus Kosambo, IMTA innovation in marine fisheries and its potential for economic empowerment Dr. Catherine Kilelu, Community Cooling Hub – Tapping into clean-energy-solutions for reducing agricultural post-harvest loss in Africa Dr. Rose Omari’, Science and Technology Policy Research Institute- Council for Scientific Industrial Research (STEPRI- CSIR) Dr. Julius Ecuru, Bioinnovate Dr. Devotha Nyambo, Digitization in Agriculture-	Joshua Owade
16:50-17:10	Facilitated discussions/dialogue Q&A 17:10 - 17:20 Wrap up reflections from UNESCO	Joshua Owade
17:20-17:30	Closing remarks Dr. Joanes Atela, Director of Outreach Communication and Partnership, ACTS	

B. CJ Seminar Flier



2nd Calestous Juma Seminar Series

Save the date

29th November 2021 - 14.00 hrs - 17.40 hrs EAT
30th November 2021 - 14.00 hrs - 17.30 hrs EAT

Theme

Steering Science, Technology and Innovation to Achieve Sustainable Development Goals



Registration Link: [Day1](#) and [Day 2](#)

About Calestous Juma Seminar Series

Prof. Calestous Juma was an internationally recognised authority in the application of science, technology and innovation (STI) for sustainable development, especially in developing countries. This seminar series, jointly organised by the [African Centre for Technology Studies](#) (ACTS) and the [Calestous Juma Legacy Foundation](#) (CJLF), are meant to honour and cement his legacy as a global icon in the application of STI for sustainable development. The inaugural seminar was held on August 12-13, 2021 and focused on *re-igniting Africa's industrialization through innovation*. The 2nd seminar will focus on steering science, technology and innovation to achieve sustainable development goals.

Seminar Focus

The 2nd Calestous Juma seminar will focus on *Steering Science, Technology and Innovation to achieve Sustainable Development Goals*. Specifically, the seminar will showcase best practices in the transformation of agriculture and fisheries sectors through integration of STI; synthesize and reflect on the lessons learnt in the global pilot programme of the STI for SDG roadmaps in Africa; launch the STRINGS project's final report; and present the findings of the case study on STI pathways on fishing/overfishing in Lake Victoria basin. There will also be presentations of case studies on STI for SDG roadmaps. Finally, the seminar will also discuss the role of STI in steering agri-food system transformation.



For more Information contact:
Maureen Kabasa, ACTS
Email: m.kabasa@acts-net.org

C. Media Piece

The screenshot shows a web browser window with three tabs: 'Regional Communications Mana...', 'Download file | iLovePDF', and 'Seminar series on Kenyan schola...'. The address bar shows the URL 'standardmedia.co.ke/national/article/2001430309/seminar-series-on-kenyan-scholar-prof-juma-starts-next-week'. The page header includes 'The Standard Since 1902' and a search bar. The main content area features the headline 'Seminar series on Kenyan scholar Prof Juma starts next week' in a large, bold, black font. Below the headline, the word 'NATIONAL' is written in blue, followed by the byline 'By Mark Oloo | Nov 26th 2021 | 2 min read'. To the right of the byline is a row of social media sharing icons for Facebook, Twitter, Telegram, WhatsApp, LinkedIn, and Email. Below the text is a large photograph of an elderly Black woman with short, curly grey hair, looking slightly to the right. The background of the photo is a blurred bookshelf. At the bottom of the browser window, a taskbar is visible with a search bar containing the text 'Type here to search' and several application icons including File Explorer, Microsoft Edge, and Microsoft Word.

Regional Communications Mana: x | Download file | iLovePDF x | Seminar series on Kenyan schola: x +

standardmedia.co.ke/national/article/2001430309/seminar-series-on-kenyan-scholar-prof-juma-starts-next-week

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