



## In brief:

1. *SolCoolDry Innovation: Beating post-harvest fish losses*
2. *KMFRI's efforts to beat plastic pollution*
3. *Fighting for seagrass survival in Kenya*
4. *A brief round-up of fishes at KMFRI*

BY: *Dr James Mwaluma, Dr Peter M. Oduor- Odote, Ms Morine Mukami, Ms Josephine Marigu and Ms Phionalorna Nzikwa* Edits: Jane Kiguta @KmfriResearch

## Innovative SolCoolDry technology a game changer in reducing post-harvest fish losses



*The Solar Drying and Cooling technology (SolCoolDry) at Mwazaro, Kwale County invented through multidisciplinary and multi-institutional collaboration*

Two German Engineering institutions -The Fraunhofer Institute for Solar Energy Systems (ISE) and INNOTECH, and three Kenyan Institutions namely Kenya Marine and Fisheries Research Institute (KMFRI), Kenya Industrial Research & Development Institute (KIRDI), and the Technical University of Mombasa (TUM) - collaborated to design, implement and roll out a climate-smart innovation. The futuristic technology uses green energy to power fish drying system and for ice production to reduce post-harvest fish losses.

The project is based on technology that utilizes the latest advances in solar-driven cooling using innovative energy storage materials and technologies such as phase-change materials (PCM), drying and food processing technologies, to process and add value to various fish and farm produce.

The SolCoolDry project, which is a short form for Solar Cooling and Drying system, involves operationalization of a research and development business hub that is co-managed by the project partners and the local Beach Management Unit in Mwazaro, Kwale County.

## Challenges facing artisanal fish value chains



*Fishfolk boiling sardines using plastic containers to prolong shelf life*

Small-scale fisheries enhance food security and support the livelihoods of the coastal communities in Kenya. The sustainable exploitation of this resource is however threatened by high Post-Harvest Fish Losses (PHFLs) which occur across the entire fish value chain. The losses are occasioned by poor fish handling skills and inadequate preservation infrastructure.



According to the Food and Agricultural Organization of the United Nations (UN-FAO), the three main types of post-harvest losses occurring within the fish value chain are quality deterioration, physical losses and market dynamics.

A combination of factors contributes to fish spoilage, which results in discard of fish, and/or low revenue realized from the sale of low-quality fish, and fish products sold at throw-away prices. Artisanal fisherfolk, in particular, encounter high post-harvest losses owing to insufficiency of preservation infrastructure and lack of proper fish handling and value addition techniques, among other factors.

Other challenges that affect traditional fish product development in developing countries like Kenya include inadequacy and low quality raw materials, limited research and development, lack of comprehensive safety and hygiene systems within the value chains, and limited accessibility to high-end markets.

The use of ice and cooling by refrigeration, and curing methods like salting, hot smoking, frying and sun drying are, depending on the circumstances, used as preservation methods in the artisanal fishery.

## Fish smoking prolongs shelf-life



*Sample image of a traditional smoking oven*

Fish smoking is relevant in artisanal fisheries in that it prolongs the shelf-life of fish, enhances flavour and increases fish utilization; reduces waste when catches are good and increases protein availability to people.

On the other hand, traditional fish smoking methods involve excessive fish handling during smoking, especially small species, making it impossible to cope with the large volumes of fresh fish landing during bumper harvest. This still contributes to high post-harvest losses. Sun drying becomes impossible if the fishing season coincides with the rainy season.

The low-capacity ovens demand more firewood to smoke fish, which increases inefficiency and contributes to forest depletion. During the fish smoking process, smokers (mostly women) breath in smoke and some enters their eyes putting them at the risk of getting respiratory and eyesight problems. They are exposed to direct heat which burn their fingers. This process is laborious and results in poor-quality smoked fish.

The SolCoolDry system fully utilizes solar energy thereby eliminating the use of firewood. It also provides a well-designed and hygienic fish processing site that minimizes contaminants and discourages handling fish with bare hands during processing. This ensures production of high-quality dried fish products and protects the environment from anthropogenic impacts of deforestation.

## Microbial contamination and insect infestation

Sun drying is a very common fish preservation technique mainly performed by women. Nevertheless, the quality of the traditional dried fish is poor, irregular and uncontrolled. Microbial contamination and insect infestation occur frequently during drying, storage and marketing.



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Most beaches on the Kenyan coast are far and access is difficult because of unreliable transport. Consequently, fish caught in these areas for sale are stored for inordinately long periods.

Fish processors, mainly women, resort to spreading out the fish on mats, bare ground or on the sand, occasionally covering them with fishing nets. They also hang them from frames of raised racks. This traditional method is slow and unhygienic, partially destroys proteins and causes lipid oxidation.

Women are compelled to shelter the drying fish every time it rains and each evening to avoid dew and its consequences such as moulds. Other disadvantages of natural outdoor drying include dust contamination, insect infestation, and exposure to harmful human and animal handling.



*Fisherfolks sun-drying sardines on the ground*



*A man operates the improved hybrid windmill solar tunnel dryers installed in Kipini*

Advances in drying have seen the development of rack dryers, solar dryers, solar tunnel dryers and the hybrid windmill solar tunnel dryer installed in Kipini.

SolCool Dry innovation can dry food products during hot and damp weather conditions, and even at night, because it produces enough energy. It also has the capacity to power neighbouring homes and produce ice on a very small scale using green energy.

That ice marks the start of improvements in the cold chain for enhanced capacity. The drying capability in hot and damp weather also is a step that will lead to larger-scale ice production and drying capability in Mwazaro under the SolCool Dry project.

## **Fish cooling is most preferred**

Fresh fish is generally more valuable and much preferred by consumers because it brings better returns to fishermen. This could be due to weak competitive structures for the cured fish compared to fresh fish industry.

However, access to fresh fish can be a problem in rural areas (inland markets) due to the shortage of ice and lack of refrigeration. Cooling, though preferred, requires expensive electricity, so most artisanal fisherfolk end up selling their fresh harvests at low prices, which is not economically sustainable.



Those who opt for drying using traditional methods suffer from slow drying processes, and unhygienic drying conditions resulting in low-quality fish with low market value. The cold chain in Africa is dotted with cold stores for the maintenance of quality. However, such cold chain efforts are not adequate, have high running costs and lack technical skill management.

In the Kenyan fishery cold chain, this is repeated, going by the number of fish cold stores received with enthusiasm only to be abandoned because of high costs of electricity, lack of technical know-how and responsibility, leading to most of them either shutting down or operating below capacity.

Running a cold chain for flake ice production on green energy, and reducing energy costs is one sure way to sustain such a facility.



*Light-weight insulated container used for storing ice and an ice production unit of the hybrid windmill solar tunnel dryer*

Coupling the cooling technologies with hygienic drying facilities in the same locality is a sure way of ensuring higher quality dried products are available in the market.

## The SolCoolDry Project Launch

The collaborating partners came together on the 8<sup>th</sup> of February, 2023 to launch the SolCoolDry facility and officially hand it over to the Mwazaro community and BMUs. The project is set to benefit over 500 fisher communities.

The Innovation Hub includes a containerized stand-alone solar technology package consisting of 100 per cent cooling and drying technology fitted with two tunnel dryers that are 2m wide and 24m long.

One of the tunnel dryers is integrated into a hot water system for nighttime performance when there is no sunlight or during damp weather. The facility has the capacity to produce 500kg of ice per day - a much-needed commodity by the fisherfolk and the general



*KMFRI Research Scientist Dr Peter Odote leading KIRDI Board member and Deputy County Commissioner on a tour of the facility*

populace of the area. The handing-over exercise was steered by the KIRDI Board Member Eng. Lucy Mutinda, Kwale Deputy County Commissioner, Mr Joseph Sawe, KMFRI CEO representative Dr James Mwaluma and Dr Mwanguli of TUM. The community is set to reap big from this innovation. Besides drying, members will be trained to produce high-quality value-added fish products, improved dried fish with desirable texture and flavor. Drying is standardized in controlled conditions which increases the shelf life of fish to at least six months.

The KMFRI technical team in the project was led by Dr Mwaluma, Dr Peter Oduor-Odote and Ms Morine Mukami.

“This technology utilizes higher drying temperatures during drying, thus preventing insect infestation and dries fish to a lower moisture content. It dries fish for a



shorter time, is hygienic, unlike the local sun drying system where the harvest is contaminated when flies come into contact with it. This technology then makes the quality and standard of the product to be higher,” said Dr Odote while addressing the media at the launch.

## KMFRI innovations complement SolCoolDry project

Organizations and Community groups present had an opportunity to exhibit their innovations, products and services.

KMFRI exhibited a lightweight insulated container for holding ice in the homesteads innovated by KMFRI Scientist Dr Peter Odote, to complement the



*KMFRI staff Ruwa elaborating to the guest of honors how the hybrid windmill tunnel works*

SolCoolDry project. This means the fisherfolk can access ice from the SolCool dry site, it is taken to their homes and used to cool the fish for convenient use later.

Other innovations were the model of the Hybrid windmill solar tunnel dryer in Kipini; seaweed products from Kibuyuni, improved fish drying racks, the “Mama

Karanga” fried fish display box and fresh value-added fish products like fishfingers, and fish samosas among others. The fish feeds formulated using dried Black Soldier Fly were also displayed as these are the potential users of the drying technologies developed.

The SOLCOOLDRY facility will benefit not only the fish mongers and BMUs but also other community members as it dries fish and other products such as mangoes, pineapple, coconut, potatoes, among others, which can be value-added, packaged and sold at competitive prices. This will, as a result, enhance the livelihoods of the locals.

Speaking at the event, KMFRI Director, Oceans and Coastal Systems Dr James Mwaluma, urged partners to collaborate with the project team in scaling up this innovation into other regions. He said besides creating employment, the innovation targets to boost food security and nutrition, and enhance livelihoods which contribute to the attainment of the 2030 Sustainable Development Goals (SDGs).



BY: ELPHAS OKOCHA Edits: Jane Kiguta  
#oceanhealth @KmfriResearch

## KMFRI shores up efforts to beat plastic pollution

In the fight against plastic pollution, Kenya Marine and Fisheries Research Institute (KMFRI), a government entity under the department of Blue Economy, has been at the forefront in coming up with interventions that would significantly reduce marine pollution. The topmost had been to identify the sources of plastic pollution and close the gaps.

This means dealing with the issue of waste disposal at the household level. To implement this, KMFRI in partnership with other stakeholders rolled out a mobile application for a waste collection dubbed “TakaConnect.” Through the app, waste collectors will get to connect with recyclers and sell recycling materials at Sh10 per kilo as a way of generating income. This will promote competition among the collectors and as a result ensure a clean environment. A recycler will also be able to tell the amount each collector has for recyclables for them to contact them and buy the recycling materials.

KMFRI researchers are working to modify fishing nets and have synthetic nets replaced with biodegradable ones. This is because the current nets if abandoned during a fishing expedition take a very long time to decompose, and continue trapping fish which impedes their movement. This affects people as fish consumers, and the life of fish because trapped fish die resulting in the reduction of fish in the ocean.

Other edible sea animals or fish can also eat the fishing net, and when humans consume such marine fish, it poses a health risk.



*Plastic waste washed to the shore in Kwale*

In their quest to control pollution, KMFRI has engaged the residents in creating awareness through education programs on the importance of a plastic-free ocean.

KMFRI has rolled out positive initiatives to curb the widespread dumping of plastics in the ocean. During the 2022 International Coastal Cleanup Day, KMFRI stole the show. It had the best strategies to curb marine pollution. The function was organized by National Environmental Management Authority (NEMA) in collaboration with other organizations like the Kenya Wildlife Service (KWS), Kenya Marine Fisheries Social-economic Development (KEMFSED) Kenya Fisheries, and Kwale County government amongst other organizations.



*Sorting out plastic waste*



In addressing the global waste management issue and safeguarding ocean health, KMFRI CEO Prof. James Njiru said the world depends solely on mother nature for oxygen and food security. KMFRI serves a critical role in food security. "Collecting the trash is not only to clean up the beaches but also to study the type of trash collected and document it for analysis," he said.

## About plastic pollution

Plastic pollution is the accumulation of plastic products in the environment in form of litter, which in turn affects humans and animals. This occurs when plastic isn't correctly disposed of, or even recycled. Plastic pollution is a menace affecting both humans and aquatic life. It has negative implications and has jeopardized ocean health, and also endangered marine organisms.

Improper disposal of plastics has the potential to exacerbate food insecurity and injure human health as more and more people consume fish laden with plastic. Plastics that find their way to the ocean also contaminate the aquatic environment which contributes to warming ocean and rising temperatures which is not conducive for fisheries resources to thrive.



## Environmental clean-up activity

Plastics are regarded as one of the best innovations humankind has had as they can be recycled, and reused in so many unimaginable ways. Plastics have

positively influenced the human race from the packaging of food to cosmetics and even beautifying our homes.

Despite plastic use being critical, the disposal of the same has been a thorn in the flesh as the biggest percentage ends up in the ocean.

According to research, about 80 per cent of litter that reaches the ocean is land-based. This means most of the items are used in households, and due to improper disposal they end up in the ocean.

In 2017, Kenya made headlines as the first country in Africa to ban the use of plastic bags, and it was preceded by the country's decision to sign the Clean Sea Initiative, a move that aims to protect marine life.

Tourists in Kenya who visited national parks, beaches, and forest areas were not allowed to carry plastic water bottles, cups, and disposal plates in protected areas. The former President, His Excellency Uhuru Kenyatta, committed to policies that could help harness the economic potential of Kenya's oceans and coastline; he called for actions that would reduce waste and plastic pollution that threatened food security, public health, and marine life.

We all want a clean ocean for posterity and future generations, and it should be in everyone's interest to maintain a trash-free ocean and adopt proper mechanisms of waste disposal and management. It should be an individual responsibility to take care of the environment.

***The writer of the article is on official attachment at Kenya Marine & Fisheries Research Institute***



BY CHARITY MUKABANE

Edits: Dr Lilian Daudi & Jane Kiguta

#climatechange #restoration @KmfriResearch

## Kenya enhances efforts to save seagrass from further degradation

*'The country has lost 21 per cent cover of seagrass between 1986 and 2016 with the cover approximated as 317 square kilometers'*

**F**rom Maputo Bay in Mozambique all the way to Wasini in Kwale, Kenya, the restoration of seagrass has been moved to the forefront.

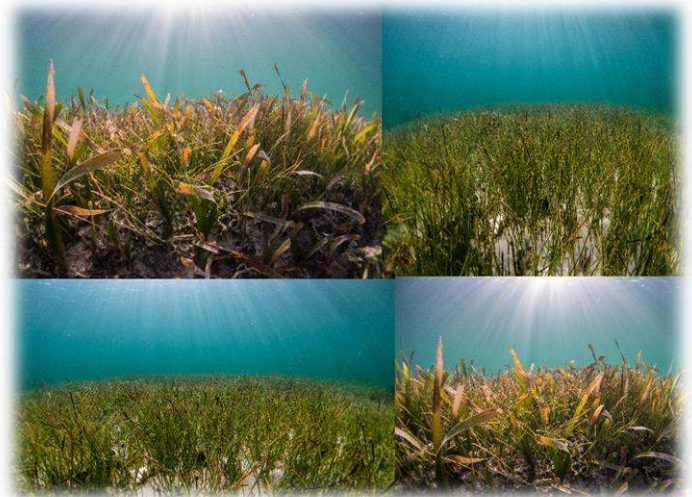
Seagrasses are important marine ecosystems found along the world's coastlines, and are facing decline due to global and local threats such as rising ocean temperatures and development of coastal urban and agriculture runoffs.

Seagrass rehabilitation began in 2015 after a baseline survey showed they were degraded. So far, around 10,000 seagrass seedlings have been planted in a 2.5 acre land in Kwale county.



Seagrass image underwater

Seagrasses are flowering plants that grow entirely underwater. They are efficient in storing carbon, stabilize the sea bottom, are food to some aquatic organisms, and help to combat the harsh effects of climate change. They also protect the coastlines, the shores, control diseases, provide shelter for marine organisms, and are vital in maintaining water balance and quality.



Seagrasses|Photo Courtesy

Commenting on seagrass restoration, Dr Lilian Daudi a marine ecologist at Kenya Marine and Fisheries Research Institute (KMFRI) said it is expected that fish numbers increase with time as a result of seagrass restoration owing to improved habitats.

She also added that seagrass can be replanted and that for large-scale replantation, the process can take a much shorter time and is more effective if mechanized. She says using mechanized ways as has been done in other regions to replant the seagrasses is much faster and covers a wider area as compared to physically planting the seagrass.

Other methods of restoring seagrass include filling excavations, applying fertilizers, placement of bird roosting stakes and coastal engineering to enhance seagrass colonization.



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The grasses help lessen the effects of strong currents, and also provide concealment and a place for eggs and larvae to attach. Plankton, algae, and bacteria grow on seagrass stems, providing food for additional organisms. Dead seagrasses provide food for decomposers like worms, crabs and filter feeders. Seagrasses improve water quality by trapping sediments, absorbing nutrients, and stabilizing sediments with their roots.

The United Nations Environment Programme (UNEP) is supporting several seagrass projects including the *Mikoko Pamoja* project in Gazi Bay to safeguard biodiversity. The project has been funded through the sale of carbon credits, and its success shows how collaboration between local, national and international organizations can lead to ecosystem restoration.

Seagrasses are a habitat to over 20 per cent of the world's largest 25 fisheries and pathogens

In Kenya, experimental restoration efforts started in 2007 to support ecosystem rehabilitation efforts - where feasible - to benefit local coastal economies and sustain fisheries.

This followed a process that has resulted in the provision of practical solutions that will allow countries within the Western Indian Ocean (WIO) region improve the quality of seagrass ecosystems by using appropriate restoration techniques that are successful.

Lillian says seagrass restoration can potentially build resilience to harsh effects of climate change.

From the restoration activities, she notes that the method of transplantation used allowed for other fast colonizing seagrasses which is an indication of success.



Seagrasses | Photo Courtesy

However, she added that monitoring of these replanted sites is important to measure the effectiveness of such restoration programme in maintaining ecosystem health.

The next step according to her will be to upscale the restoration programme to other areas along the coastline. This is necessary because Kenya has lost 21 per cent cover of seagrass between 1986 and 2016 with the cover approximated as 317 square kilometers.



## A snippet of fishes used by KMFRI for experimental research

sodium. Calcium and phosphorus are essential nutrients for the growth and the main elements of the structural components of human bone tissue. KMFRI's researchers have farmed milkfish in Kwale County. [By Barbra Muhonja \(Attachee\)](#)

### Milkfish



*Photo/Courtesy*

Also known as *bandeng* or *bangus*, milkfish is a silvery marine milk fish, the only living member of the family *chanidae*. They are long and almost compressed with a symmetrical and streamlined look. Milk fish are frequently caught as juveniles and bred for food in brackish or freshwater tropical ponds. Milkfish is an omnivore, meaning it feeds on both plants and animals. Milkfish eats feed suitable for its age. While juveniles consume bacteria such as algae, worms, small shrimps and carrion, newly born larvae devour zooplankton. They can survive in salty and fresh water, but only reproduce in sea water. Milkfish are rich in minerals such as potassium, calcium, magnesium and

### Marine Tilapia



Tilapia are mainly freshwater fish found in shallow streams, rivers, ponds, and lakes. Nile, blue and Mozambique tilapias are the most commonly eaten species. They are rarely found in brackish water but hybrids which have shown high degree of tolerance to seawater are called Marine Tilapia because they survive in saline brackish water. This has opened coastal areas to marine tilapia farming, and if successful has the potential to expand global production. Tilapia is rich in vitamin B12 and is highly profitable in Kenya. They take about five to eight months to mature. Tilapia saltwater culture is carried out in earthen ponds, tanks and pools, cages and recirculating tank systems. These have been implemented at both experimental as well as in commercial operations in the Caribbean (Jamaica, Puerto Rico, Mexico, Ecuador), Asia (Taiwan, Thailand, Philippines) and various Northern Africa and Middle East countries (Kuwait, Saudi Arabia, Egypt). [By Chelsey Achieng \(Attachee\)](#)



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## Sea Cucumber



Sea cucumbers are marine invertebrates from the class *Holothuroidea* and kingdom Animalia. They include starfish and sea urchins. They have leathery skin and an elongated body containing a single-branched gonad. There are 1250 known species. Their average life span of 5 to 10 years. They eject parts of the gut to scare and defend against predators. Sea cucumbers feed on tiny particles like algae, minute aquatic animals, and waste materials. They use 20-30 little tube feet around their mouth to shave everything including sand. They breed sexually or asexually. Sexual reproduction is more typical but the process is not very intimate. They release both eggs and sperm into water and fertilization occurs when they met. It is claimed that they are used in traditional Chinese medicine. It is also a rich source of chondroitin sulfate. Sea cucumbers are low in calories and fat. They deliver beneficial compounds including protein, antioxidants, and vitamin B. **By Caroline Nkirote (Attachee)**

Edits: Jane Kiguta

## African Catfish



African catfish is also known as mud catfish from the family of *clariidae*, the air breathing Catfishes. They are found in lakes Turkana, Inle and Chilwa. It's one of the most widely cultured fish species in South Africa. It's a good candidate species for culture to boost fish production for both domestic and global markets which improves human nutrition and food security in Africa. African catfish is mainly cultivated under mixed-sex semi intensive systems in ponds. The ponds are fertilized with organic manure and the fish are fed on supplemental feed. Catfish is low in calories, is a high protein seafood and a great source of nutrients including vitamin B<sup>12</sup>, selenium and omega 6 fatty acids. However, catfish has an increased risk of memory loss from PBCs sickness due to bacterial contamination. African catfish is one of the most ideal aquaculture species in Kenya and a potential source of cheap protein for human nutrition. It contributes only 18 per cent of total farmed fish compared to Nile tilapia, which contributes 75 per cent of total production. **By Sharon Cheruto (Attachee)**



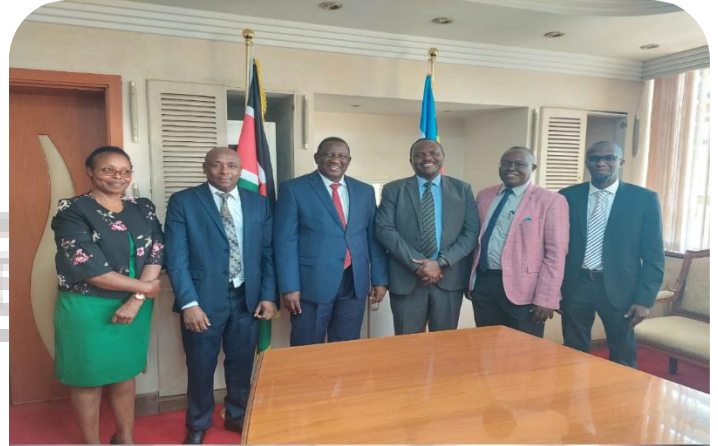
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## PICTORIALS

Compiled By: Jane Kiguta & Brian Isoe



*Mining, Blue Economy and Maritime Affairs CS Hon. Salim Mvurya with Fisheries PS Madam Betsy Muthoni Njagi meet Chairpersons and Chief Executive Officers of State Agencies namely KMFRI, Kenya Fisheries Service (KeFS), Kenya Fishing Industries Corporation (KFIC), Kenya Fish Marketing Authority (KFMA) & Fish Levy Trust Fund (FLTF) to discuss the ongoing programmes and plans for the Financial Year 2023/2024, engagement with development partners and to align the programmes and projects to the Kenya Kwanza Plan.*

*Burhaniya Junior Academy students during an academic visit at KMFRI headquarters, Mombasa. They were keen to advance their knowledge on Fisheries and The Blue Economy and had a tour of the institute's museum, aquarium and later on a presentation on KMFRI's role in curbing climate change through the Mikoko Pamoja initiative.*



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*Student officers currently doing the Senior Joint Command and Staff Course at the Joint Command and Staff College tour KMFRI's experimental fish ponds during an official visit to the Institute. The students who were accompanied by Directing Staff learnt about KMFRI's mission and her role in harnessing the Blue Economy through research for the overall economic growth of Kenyan economy.*



*Attendees of the inception meeting for the project dubbed "Supporting marine small-scale fisheries sustainability as a basis for safeguarding Food Security and Livelihoods in East African Region (SAVEFISH)" at KMFRI headquarters.*



*KMFRI Assistant Director for Oceanography and Hydrography Dr Joseph Kamau, representing KMFRI CEO, with a team from the University of Nairobi's Center for Advanced Studies in Environmental Law and Policy (CASELAP). The team which was led by Prof.Collins Odite, the CASELAP Research Director and Associate Dean of the Faculty of Law, was on a scoping mission as stakeholders in the maritime sector to see the place of KMFRI research in marine pollution especially the gaseous emissions and efforts put in place to control climate change.*



*KMFRI team accompanied the Mombasa County Deputy Governor Mr Francis Thoya who was on a site-visit to assess the impact of a Constructed Wetland Wastewater Treatment Technology developed by KMFRI at Shimo La Tewa Maximum Security Prison.*



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*KMFRI staff Jesse Memba (right) and Douglas Mandela (left) with fish samples collected from Lakes Naivasha and Baringo for preservation before displaying them in KMFRI museum. The samples were immersed in concentrated formalin before being sun-dried and later put in the museum.*



*KMFRI Assistant Director Dr. Nina Wambiji (top) leading panelists discussion on Harnessing Blue Economy for Inclusive Growth at the Coast during British Council and Twaweza Communications Utamaduni Conversations held in Mombasa. Bottom, participants at the forum.*



*KMFRI Board member Mr Valentine Mwakamba in Kegati during quarterly Board of Trustee meeting where KMFRI staff were educated on additional voluntary contribution, annuity, income drawdown, pension benefits, among others.*